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A RATIONAL APPRENTICE SYSTEM.

[EDITOR'S NOTE.—In the June issue, page 201, we presented the first of a series of three articles on the New York Central Lines apprentice system, which are intended to present in detail the workings of the system and are supplementary to the paper on the same subject presented before the Master Mechanics' Association by Mr. C. W. Cross, superintendent of apprentices, and Mr. W. B. Russell, his assistant.

This is the first apprentice system which has been introduced, on a large scale on a railroad in this country, which has in it the elements that are necessary to adequately meet the present conditions and build up a body of skilled workmen for the future. The great problem before our railroads and manufacturing industries today is not that of better shops and equipment, or even of better methods of operating, but is that of *men*. It can only be solved by improving the organization with a view of bringing the efficiency of each individual worker to the highest possible point and by preparing skilled workmen for the future. The keynote of the situation was sounded in the presidential address of Mr. J. F. Deems before the Master Mechanics' Association, part of which is reproduced following this note.

The paper by Messrs. Cross and Russell was on the program as a topical discussion but it very soon developed that it was the most important subject before the Association, and this meeting will go down in history as the one at which it was considered. One hour was allowed on the program for the presentation and discussion of the paper, but when after over an hour and a half it became necessary to adjourn, it was unanimously voted to devote the noon hour of the following day to it. Never before has this been done.

Two years ago Mr. G. M. Basford stirred the Association by his masterful paper calling attention to the imperative need of installing adequate apprentice systems on our railroads and presenting the outline of a system to meet the present conditions. It must indeed be a matter of great satisfaction to him to see his plans being successfully applied and perfected on the New York Central Lines and to know that other roads have started the work on a smaller scale or are preparing to meet it in a similar way. The railroads cannot thank him too much for the impetus and direction which he has given to this movement.

The discussion was so important that parts of it are reproduced.]

Extract from Mr. Deems' Address.

No war-bronzed veterans ever had deeper inspiration or greater cause for self-forgetful devotion than had the pioneers who bore the brunt of the early days of the development which this Association has so splendidly advanced. All the honors accorded to military achievement in the past, but illy compare with those which the future will gladly erect to the memory of the men who have given us that grander, that more useful development—transportation—without which to-day the world would be largely a waste. Our predecessors met in a small way and singly the problems which we and those who follow us must meet collectively and in a larger sense, and to solve which it will be necessary to form great combinations that must be harmonious, cohesive and permanent. It is no slight task to conceive and build a structure that will provide for the interchange of people, the mutation of ideas and the physical distribution of that which enters into man's every need. We are fortunate in that our fathers built so well, let us hope that those who follow can truly say the same of us; let us devote ourselves seriously to the problems of to-day; the chief among which is to try to do as well the things that come to our hand as our predecessors did with the smaller things that came to their hands.

A legacy has been bequeathed, a legacy for which all preparation has been made, a legacy of opportunity which looms large in the future and awaits with rich reward the man who is prepared—*the man who is prepared.* We have received; what shall we give? We have inherited; what shall we bequeath, what shall we leave to aid in solving the problems of the future, many of which may be much more perplexing than those we are called upon to solve to-day? We may work in brass and steel, and leave the most perfect mechanism—we may develop and improve and evolve methods and practices until nothing more can be desired—we may reach perfection in all these, in mechanism, structure and method, and yet our bequest be a failure and itself a burden unless we provide that which is paramount, which is over and above the sum total of all of this, and for which, even to-day, events throughout the world are crying aloud—*the man. A man prepared, experienced, earnest, hopeful and happy, consecrated to his work and ready to give the hand to the future.*

This, my friends, as I see it, constitutes our greatest opportunity, our most imperative, our most sacred duty. If the man is provided, the machine will cease to be a burden and methods will come forth as the buds at the kiss of spring. *Our own future, and the hope of that larger future which lies beyond, depends on our efforts and our success in providing those who are to help us to-day, and upon whom at no distant day must fall our duties, our opportunities, our honors and our failures.* Have we any greater, grander, more sublime obligation than this? Can we justify a pride in our life-work, if we fail in this? If I can but bring to you this single message, if I can inspire you with this one thought, I am content.

The Apprentice System on the New York Central Lines.

BY MESSRS. C. W. CROSS AND W. B. RUSSELL.

The object of this paper is to present briefly the main features of a plan, already in successful operation on a large scale, which aims to meet a genuine need in a direct and common-sense manner, a plan worked out primarily to meet the specific needs of a particular group of shops, yet based on general principles that will make it workable anywhere.

Purpose.—The purpose of the apprentice system is to provide the motive power department with an adequate recruiting system which will eventually produce from the ranks a large number of skilled workmen, a number of foremen, a sufficient number of good draftsmen, a few master mechanics and an occasional superintendent of motive power.

The subject of an approved apprentice system has long been a favorite scheme of Mr. J. F. Deems, and was first mentioned by him on the New York Central Lines in December, 1902; it was not until March 1, 1906, however, that arrangements could be made to inaugurate the plan. At that time the authors of this paper were engaged to take charge of the work. The first apprentice class under this plan was started at the West Albany shops, May 7, 1906. Much of the general idea and many of the details have been worked out in conformity with the suggestions made in a paper on this subject by Mr. G. M. Basford, read before this Association at the 1905 convention. Mr. Basford expressed the necessity for this work in these words: "The engineering and the operating situation on railroads is in advance of its men, and in many ways the problem has outgrown both the individual and methods of dealing with the individual, and especially has it outstripped methods of preparing men for their work."

Plan—Trade and Educational.—The general plan is twofold, and provides for shop instruction of the apprentice in the trades and also for his instruction in mechanical drawing, practical mathematics and shop problems during working hours while under pay.

Inauguration.—A department headquarters was first organized to outline the courses of instruction and to prepare the necessary instruction sheets and text-books. Two instructors—a shop instructor and a drawing instructor—were then appointed at each of the larger shops; a uniform set of apprentice regulations was adopted for all shops and a schedule provided showing the time allotted in the shop to each class of work. This schedule is sufficiently flexible to insure a prompt movement of the apprentices from one class of work to another and to still leave opportunity for rapid movement in case of special merit. Both the shop instructors and the drawing instructors are under the local shop officers and responsible directly to them. Regular reports are made by both instructors to their immediate superiors, who forward them to the apprentice headquarters. In the educational work, however, the instructors are kept in direct touch with the apprentice department.

Difficulties.—There are really no serious difficulties, except that

of securing the thorough and hearty coöperation of everybody in the scheme. The work can not be successful without the enthusiastic support of the administration and of the local officers. In the inauguration of a plan of this nature the following points are sure to present themselves:

1. The selection of a shop instructor already employed in some capacity at the shop in question, who is preferably an up-to-date all-around machinist competent to give direct instruction in the machinist trade, but with sufficient knowledge of the other trades which may have local apprentices to be able to intelligently supervise apprentices in those trades.

2. The selection of drawing instructors, preferably draftsmen or mechanical engineers, who possess the rare qualities necessary to successfully instruct ungraded classes under new and trying conditions.

3. To obtain and equip suitable class-rooms located near the center of the shop property.

4. To secure the hearty coöperation of shop superintendent, foremen, gang bosses and mechanics who have been trained under a different system, and whose coöperation is essential to make such an apprentice system a success.

5. To obtain from the average apprentice a proper appreciation of the opportunities offered and an enthusiastic endeavor to make the most of them.

6. To introduce the training system for apprentices in a manner that will not interfere with the operation of the shops.

Present Operation—Extent.—The plan is now in operation at nine of the largest shops of the system, and includes about 450 apprentices. The work is gradually being extended to the smaller shops. The drawing instructor in every instance is a draftsman or mechanical engineer, located either at the shop or a company drafting room close at hand. The shop instructor in most instances holds some other position in the shop in addition to that of apprentice instructor. The apprentices are under the foreman, and responsible to him as formerly, but the foreman is relieved of the duty of instructing them in the trade, thus enabling him to give his entire time to directing the work of his department.

Methods.—The work in drawing and shop problems is outlined at the apprentice headquarters at New York City, and sufficient flexibility is allowed to fit the personality of the local instructor and the needs of the local apprentices. The plan of instruction is arranged to give the closest possible connection between the work in the shop and the work in the classroom. In fact, the practical and theoretical parts of the work are so thoroughly united that the grease of the shop is literally rubbed into the lesson sheets and drawing papers. Subjects are not classified as in most school systems, but the necessary mathematics, mechanics, physics and chemistry are introduced only as needed to solve some practical shop problem. The drawing is from actual parts from the start, omitting all exercises and preliminary geometrical work as such, and introducing principles only as needed to gain practical ends. Simple blue-print sketches are used for the drawings in connection with the actual machine parts; printed sheets are supplied for the problems. The shop instructors coöperate with the drawing instructors in looking after the general welfare of the boys. Arrangements are made for the instructors to make occasional visits to other shops to observe methods of instruction. Apprentices are sent to visit other shops and report their observations.

Class Work.—The instruction is largely individual, with classes limited to twenty-four apprentices at one time. By use of the blue-print sketches, on which are the necessary directions, it is possible for the instructor to hand an apprentice a sketch and a machine part, thus enabling the apprentice to start at once on the work. This method permits the instructor to keep a class of twenty-four busy, even when each member is working on a different sheet. The first drawings are very simple, so that accuracy may be insisted upon from the start. In order to save time and have corrections made at once, no work is removed from the drawing board until it receives the instructor's O. K. The work is scaled so that it can not be copied from the sketch and the course is arranged to advance more slowly than usual drawing courses. One principle is introduced at a time, and then only as needed to make an actual car or locomotive drawing. Lettering is an incidental item. The shop problems are usually worked at home on standard sheets, and an occasional blackboard review is given in class. The home work is assigned on loose printed sheets which makes it possible for an apprentice to go as rapidly as he desires. In the courses that are now used, much that is dear to the mathematician and physicist has been left out. All the work that is introduced is in accordance with the New York Central Lines practice, from which illustrations are selected. A comprehensive system of reports is made by both instructors to the local shop officers. These reports show: First, the ability at the trade; second, the disposition and personality of the apprentice, and, third, the standing in class work. The instructors are at all times required to know the standing of each apprentice, thus making examinations unnecessary. Special emphasis is placed on the personal touch maintained between the instructor and the apprentice, with a view to determining the type of work or branch of service for which the boy is best fitted. It has been found necessary to use great care in selecting instructors, who must be men who are not only competent, but who are willing to undertake the work for the love of it and their interest in the young men, as well as for the remuneration they receive. At the expiration of apprenticeship, those who have satisfactorily completed their term receive certificates which entitle them to preference in employment at all shops on the New York Central Lines.

Hours.—Instruction is given each apprentice four hours a week during shop time; that is, two mornings from 7 to 9 o'clock. Such instruction is all classed under the name of mechanical drawing. Apprentices ring in before coming to class and are under shop discipline during the session. At 9 o'clock they proceed directly to the shop. Home work is expected on the problems. Both instructors are available for consultation during the noon hour.

Facilities.—The facilities for handling work of this nature on a railroad are almost boundless. The authors appreciate the fact that they have only made a beginning thus far and that the apparatus at hand in most railroad shops would rival the outfits of some of the laboratories in the large technical schools. It is possible to have occasional demonstrations in the company's testing laboratories and to conduct steam consumption tests on locomotives and power plants. Home-made apparatus can be readily constructed or old machines altered to make satisfactory demonstrations of the most useful and fundamental laws of nature, and, better still, the practical applications of these principles can be shown in machines and other appliances on the shop property. The concentration of motive power responsibilities of a number of roads under a single general officer renders it possible to inaugurate a much more comprehensive plan than a single road or a number of small roads could attempt.

Attitude of Men.—The rank and file, not excepting the politician, the labor reformer, the practical joker and the workmen of all grades and peculiarities, unite in giving their approval to a plan, the object of which is to train their own sons in a business that will enable them to gain a livelihood and possibly advance to a position of authority and responsibility.

Interest of Apprentices.—No more interesting study has presented itself than the personality of the average apprentice. On the whole he is below the standard of education and ambition generally presumed by most motive power officers, who naturally think all apprentices possess the same exceptional initiative and earnest endeavor which has brought them up from the ranks. The average apprentice possesses a great deal of human nature; he means well, intends to make the most of his opportunity, generally prefers to be a real boy and to enjoy life, rather than to work problems at home; he will not read a text-book except under compulsion, and has absorbed a little of the idea that the easiest way to become a journeyman is to do as little work as possible. On the whole, however, the interest of the apprentice is good, and is increasing in proportion as the facilities for experimental work are increased and the plan of instruction is extended. There are instances where the boys have kept the local instructors busy in supplying them with work, and it is evident that the ambition of many boys has been aroused and

that the right chord has been struck, so that in time the boy without ambition will become a rare article. Reports show that apprentices started during the last year have evidenced a most commendable enthusiasm. On January 1, 1907, there were no less than forty-five letters of commendation from the superintendent of apprentices. It might also be interesting to state that at nearly all points there are advanced apprentices who take full charge of classes when the instructors are absent.

Effect on Apprentices.—The effect upon the apprentices has been awakened interest and marked improvement in skill in the shop, ability to read drawings, ability to lay out templates, and in several cases skill in drafting sufficient to warrant assignment to the drafting room for sixty-day intervals.

Effect Upon Output.—It is difficult to determine exactly the effect upon output. The time spent in class, four hours per week, would appear to cause a slight decrease, but this is more than offset by the increased skill of the apprentices, due to the presence of the shop instructor, to make each machine count, even with a green apprentice. It should be understood that all of the work done by the apprentices is on the regular shop machines and forms a part of the shop output.

Effect Upon Men.—A feeling among the men that perhaps the apprentices would outdo them has been met by the organization of evening classes for foremen and mechanics at seven shops, taught by the drawing instructors of the apprentice department. The finances of these classes are handled by the instructors, while the company provides the use of the room, light and heat, and gives the men the benefit of the courses provided for the apprentices, with the slight changes necessary to suit the conditions of the evening classes. The men provide all their own materials and drawing instruments. The classes meet once or twice a week for two-hour periods, either directly after working hours or in the evening. While the total enrollment was but 150 this year, it nevertheless expresses the general feeling among the leading men in each shop. The result has been a closer intimacy on the part of the shop men with the shop draftsmen and with company standards.

Effect Upon Instructors.—The effect upon the instructors themselves has been most pleasing. Without exception, they have developed, not only as enthusiastic instructors, but also in all-around ability. The exigencies of teaching have brought them in contact with many features of the service previously overlooked and the occasional observation trips and interchange of ideas have already made them more valuable to the service. Many valuable suggestions have been received from the instructors and adopted.

Treatment of Apprentices after Graduation.—Perhaps as vital as any other principle is the necessity for caring for graduates with infinite pains after they have completed their apprentice terms. The results of the best possible apprentice system may be absolutely nullified if the organization into which the graduates are to go is not properly prepared to receive them. It is not too much to say that most railroads and most large industrial establishments need to put their organization in such order as will render not only employment desirable, but advancement possible. As an incentive to all and a reward to the especially studious and proficient, it is desirable to give a limited number of those showing the best records a prize in the way of a more advanced course at a technical school at the expense of the railroad; the young man to work in the shops during vacation time, thus retaining his close relationship to the work.

Probable Results.—It will undoubtedly take years to show the full value of the apprentice system. Already draftsmen are being provided for the company drafting rooms, and New York Central standards are becoming familiar to all apprentices. In the future every journeyman will be able to read drawings and make working sketches. Men will show greater pride in their local shop and increased loyalty to the company, and the tendency to resign their positions for work with other companies will be lessened. It is not expected that all of the boys will attain a degree of efficiency that will qualify them for leadership, or that all workmen will possess the same measure of ability and activity, on account of the difference in their natural intellectual and physical qualifications, but it is expected that each will be developed to a high degree in his particular line, with the result that eventually each shop will be manned by a force of mechanics embodying an advanced state of proficiency from which at least a few competent men may be had at all times for positions of leadership.

Attitude of Other Roads.—The criticism has been made that the New York Central Lines is educating apprentices for other roads, and the statement is to some extent true at present. The awakening of interest, however, in industrial education, and the inquiries and observations from all directions, indicate that other railroads are now giving this matter the consideration it deserves, and in some instances have taken action with a view to inaugurating some part of the plan proposed. The fact is being appreciated that no outside system of instruction, such as trade schools, correspondence schools, or even Y. M. C. A., can fully meet the needs of the apprentice, and that the control and direction of the instruction must be coincident with the control and direction of the shop. The indications point to a day not far distant when each railroad will have a fully equipped apprentice system organized as an integral part of its motive power department. Before such work can start, the management must be convinced that for its own safety in the future it must be provided with skilled, intelligent native workmen; men who can stand on their own merits and do the work which is needed to keep this country commercially ahead of the world; men who need hide behind no organization to command the respect of their employers; men who can and will bring skill and judgment to their work so that they may command compensation commensurate with their increased ability.

Abstract of Discussion.

Mr. A. M. Waitt.—It seems to me that at the present time there is no more serious problem confronting the railroads, and especially the mechanical department of railroads, than the future relationship between the employes in the mechanical department and the companies. We find that probably as much of the time of motive-power officers is taken up in considering the difficulties of the labor problem as is devoted to strictly technical subjects. The growing tendency to specialization seems to have led to a lack of general all around mechanics, and it has been noticed in probably every shop in the country that there is a great dearth of suitable men when a good man is desired for the position of foreman. The problem has got to be faced, and it seems to me that the step taken by the New York Central Lines, on a comprehensive and broad scale, is one of the most important ones that has been taken by railroads in this country for a long time. Especially it seems to me fortunate that the New York Central people should be willing to make public, even in the early days of their apprenticeship system, what they are doing, what they are contemplating, and the methods by which they expect to produce greater results in the future than they have in the one year in which the system has been in operation. I was very much interested since coming here to see that as a supplement to the paper prepared by Mr. Cross, the AMERICAN ENGINEER AND RAILROAD JOURNAL had published a lengthy article, which it would appear is going to be one of many, outlining in detail the system that has been inaugurated on the New York Central Lines. I read it somewhat hastily, but with a great deal of interest, and I believe it can be read with profit by every gentleman who is present at the convention, for I think there is nothing more important for the future good of railroads, for raising the standard of mechanics in the shops, than the establishment of a thoroughly comprehensive and wisely carried out system for educating apprentices, so that we can have good all-around mechanics.

There has been a tendency lately, in connection with various organizations, to lower seemingly the standard of efficiency of the men. I believe that a system such as has been outlined by Mr. Cross is one of the steps to offset that tendency and to raise the standard permanently, so that instead of going through our shops and comparing the present class of men with those of fifteen or twenty years ago, and commenting as we do now that they are not up to the old standard, that we may in five or ten years from now look through the shops and find the standard constantly improving, and so that the railroads may be looked to as an example of the best methods of raising the calibre and the general standard of the mechanics.

There is a common tendency in shops for general foremen to feel that they must, in taking young fellows into the shop and training them eventually to become mechanics, get all that they can out of them, forgetting that one of the desirable features in training apprentices is to make them first-class workmen. The value cannot come in the first years of their apprenticeship, but just as surely as they are properly trained the value will come

to the company and to the community at large after they have been properly trained.

Mr. J. A. Pilcher (Mechanical Engineer).—In connection with the apprenticeship question, the Norfolk & Western has a system of allowing the apprentice a certain amount of time in the draughting room. That has been carried on for several years, with the result that our most efficient draughtsmen are men we have secured from the shops originally as apprentices. In several instances where men did not develop just the talent we would have liked for the draughting room they have gone back to the shops, and later on I would find they were made gang foremen.

Mr. Harrington Emerson.—I think all those who have had to do with labor in railroad shops have felt very much the need of providing some method of training to develop the future workers in the shops, and therefore will welcome this magnificent work that has been going on in that line on the New York Central Railroad. On the Santa Fé I have felt that need because we had there nothing that could be called an apprenticeship system. We had the old method of taking in apprentices, of getting what we could out of them, and getting what assistance we could through certain classes of the Y. M. C. A.

We have, however, been fortunate in being able to check up the work of the apprentices, the work they were actually doing against what they ought to do, and I think it might be of interest to give this meeting a statement of what apprentices under the old system were doing—which I hope will soon become obsolete—and perhaps sometime in the future it may be possible to find out what they are doing under these new systems that I hope to see spread. In the boiler shop we had 23 apprentices whose average efficiency was 87 per cent. in the work that they did. The efficiency of the whole shop, including the apprentices, was 94 per cent., so that the apprentices as a rule were below the efficiency of the men. On the list I found one apprentice with an efficiency of 136 per cent., and another with an efficiency of only 43 per cent. Coming to the machine shop there are 56 apprentices with an average efficiency of only 69 per cent. The first man on the list has an efficiency of 136.8 per cent., the next man an efficiency of only 33 per cent., showing the tremendous variation in individuals. The first man is four times as good as the second man, and my impression is that throughout life he will steadily gain, as time goes on, and he will not be only four times as good, but ultimately ten or twenty or one hundred times as good, and one of the features that perhaps is necessary, is to check up the apprentices throughout their course of service with reference to their efficiency, so as to encourage those who show a high degree of efficiency, and if possible divert those that show no ability whatever into possibly other walks in life. During the time of apprenticeship, more than at any other period of life, it seems to be necessary to impress upon the apprentice the question of his own efficiency, that what he is learning is not simply to absorb a certain amount of knowledge, but to carry it into actual work so that he himself becomes efficient.

Mr. D. R. MacBain (Michigan Central).—While the system has been in force only a little over a year, the results so far are very gratifying and the conditions are bettering all the time. When we were trying to carry out our old system of apprenticeship, when we undertook to have the apprentices attend a course of instruction for an hour or an hour and a half after the work of the day, we found that we got little results—the boys did not put the enthusiasm into the work which they are doing now.

We find also since the inauguration of the new system, and particularly within the last five or six months, since the thing has become advertised to a considerable extent, that we are getting a much better class of young men than before. They have learned and understand now that our apprenticeship system is very much like a fairly good technical education. For that reason there are many more applications than we can take care of.

I believe a more liberal treatment of the boys after they have finished their apprenticeship will be necessary. We have in the last two or three years broken away from the old practice of increasing the boys 25 cents a year after the apprenticeship, and instead of that have been governed by the recommendations of the machine foremen, general foremen and others. The result of that is we are saving to the Michigan Central Railroad men whom we believe in most instances are superior to the first-class journeyman who may apply for a position.

Within the last three months two of our apprentices who took up this work when the system was inaugurated a year ago have been called into the mechanical engineer's office. One is in Mr. Gilbert's office in New York and doing well. Another man was called into Mr. McRae's office in Detroit. Such instances as these are the very best recommendations which can be made for the system. We no longer have the trouble we used to have to get the boys to stay and work through the period of apprenticeship.

Prof. H. Wade Hibbard (Cornell University).—We find in an engineering college that a very great deal of good comes to us from the opportunity we have in a faculty, of say fifty engineering professors and instructors, of discussing things together. It strikes me as the New York Central has its meetings of motive power officials at various periods, that the superintendents of the apprenticeship instruction courses might as often or oftener hold meetings of men engaged in this work of instruction, that they may come together and talk over the subjects, some of which could be outlined beforehand, and some of which could be brought up on the spur of the moment, that are necessary for the continued progress and the excellence of their work. It will be necessary that the students in the apprenticeship course should be aided in every way so that the enthusiasm in the courses may be kept up. A new thing is attractive, but when the novelty is worn off, the attractiveness diminishes and the enthusiasm begins to wane. It strikes me that special effort should be concentrated upon this, as in other matters of the course, to keep up the enthusiasm all through the line—enthusiasm of instructors and the enthusiasm of the apprentice boys.

Now with regard to the instructors, I wish to make a suggestion, and that is the danger which may come from the men who are doing the instructing in the different shops, leaving the service of the company, being promoted, having duties placed upon them inconsistent with the carrying out of the duties they are now carrying out in the apprenticeship instruction work, etc. Of course, in our university work we have professors who leave the college, but there is so concentrated an interest by having a large number of instructors in one faculty, that the purpose of instructive work as a continuity, even though one or two professors occasionally leave is not broken.

Mr. G. M. Basford.—Nearly all railroads and industrial establishments have preached apprenticeship and nearly all have made serious efforts to practice it. In spite of this it would probably require from 40 to 70 years for most of these establishments to recruit their service of skilled labor through apprenticeship if they relied upon present methods for the purpose. The past generation and the present have brought a tremendous growth to all our organizations, the extent of which none of us, probably, fully realizes. We have greater need than ever for trained young men ready to be trusted with responsibilities.

For many years the technical schools have done their best to supply men for leading positions, and yet we are suffering for men to fill subordinate positions. Well-prepared men from the ranks are what we want. This plan so clearly described by the author of this paper will undoubtedly produce them. We need definite, systematic apprenticeship, adapted to present conditions. Even if we had plenty of apprentice material, shop people are too busy to teach boys, and if the boys are put into the shop organization to learn trades, under prevailing conditions they will quickly absorb much that is harmful and more slowly learn some of the things we wish them to know. Under present methods and conditions, they certainly cannot be said to learn trades. This plan insures the acquisition of a trade. It does more. It also insures mental development to correspond, and a certain moral training must necessarily result.

For sixty years the British navy has profited by a plan somewhat similar to this. It is, therefore, clear that this plan does not contemplate the tilling of new soil.

The State of New York, at the Elmira Reformatory, in 1894, provided instruction in 34 separate trades to those who were (shall we say) fortunate enough to have an opportunity to learn them. In 1879 a school of letters was established at the same institution as a part of an elaborate and effective educational scheme. If we had needed any precedent, here we had one years ago, and it will be to our everlasting disgrace if we permit it to be truly said that a young man, in order to learn a trade needs to commit a crime against the laws of the people.

The New York Central has shown the way to solve the recruiting problem practically. Let us hope that all other roads and manufacturers will follow as rapidly as possible.

Mr. E. Chamberlain (N. Y. C.)—Most of us have served our time at a trade, and many have been apprentices, and we know the difficulties we have had to overcome in becoming masters of our trade. If you were to see upon the New York Central Lines as a whole, the eagerness, the ambition of these young men to better their conditions through the privileges afforded, at the expense of the company, it would be a marvel to you indeed.

Mr. William McIntosh (C. of N. J.)—In former methods of apprentice instruction the effort has always been made to give the boy instruction outside of the regular working hours, expecting them to go back to the works after the regular hours of the day and to give considerable time at night to instruction. It is not surprising that it did not prove successful, for the reason that very few of us who have passed the apprenticeship period would be willing to put in additional hours in that manner if we could avoid it. Therefore, the plan adopted to give instruction during regular working hours is one of the important features of the system, and one that is absolutely necessary to meet with success.

The road with which I am connected was interested in improving the apprenticeship system by methods of instruction some time ago, and in 1905 we established a school in connection with our road very much along the lines of the New York Central. I want to give due credit to Mr. Basford for the effort that he put forth to induce railroad people to take up these methods of instruction. It was largely due to his suggestions in this connection that our people were induced to adopt the plan. I believe we have sixty scholars under instruction at the present

time, and some of them advancing very rapidly, so much so that I do not think the New York Central need fear having to lose all the graduate apprentices, for we would be able, in proportion to the size of our road, probably to reciprocate to a modest extent. Our experience has been most satisfactory.

Mr. LeGrand Parish (L. S. & M. S.)—This method of instructing apprentices is a good, sound business proposition, no theory in it. We have found that by placing an instructor in the shops to instruct the boys we get a much greater output from them. We are not losing anything in the matter of dollars and cents, and, from the financial point of view, we are gaining. I have also found something which will be of interest to everybody concerned, and that is that in discussing this matter a short time ago with a committee of our machinists they expressed themselves as delighted with the system, and, in fact, gave me considerable concessions in connection with the number of apprentices, showing conclusively that the men themselves are in thorough sympathy with the plan.

Mr. L. R. Pomeroy.—It seems to me this plan has in itself the essence of success, because it is not philanthropic. I think the system has just this advantage, that we can make better journeymen out of the ordinary apprentice, with the possibility of now and then finding a good foreman. My mind has been going over the numerous schools which have been started along these lines, notably the work done by such men as Reynolds, at Brainerd; W. Slacks, at Denver; Linmark, at Chicago; Reed, of the Chicago & Great Western; Wilkinson, at Jackson; Bradley, at Ann Arbor, and Brooks, at Dunkirk. Notable work was performed at every one of these places, but the fundamental difficulty and the cause of failure was that they had no control over the men, it was all voluntary. Under this system, where the company pays them for the time that they are giving to instruction, the question of discipline is prominent, and it gives them a better control and direction over the men.

Mr. D. J. Redding (P. & L. E.)—I am connected with a shop having one of these schools. One of the difficulties mentioned in the paper is to obtain from the average apprentice a proper appreciation of the opportunities offered and an enthusiastic endeavor to make the most of them. I want to say we feel that this has been overcome from the fact that in some cases apprentices have asked permission to attend the night classes as well as their regular day courses, in order that they may advance more rapidly. I have one case of a man employed as a machinist working at full wages, who worked up to that position from laborer, who came in and wanted to enter the shop as an apprentice and was willing to serve two years in order to get the advantages of the course.

There is no question but that the average apprentice when he first comes in as a boy, 16 or 17 years old, is, as a general thing, not interested. He does not know whether he really wants to be a machinist, boilermaker, or blacksmith. We observe that their interest in the work develops more after they have been in the shop for some time, a year or two, and we also find that some of the mechanics who have developed themselves under this system are men who went into the shop as laborers and depended on their own resources to work at different callings, but found without some special training they would not advance very far. After they have worked in the shop a year or two they are given opportunity, if they desire, to give a portion of their time under the apprentice system, and these men usually make very good mechanics, because they realize they must learn a trade to get on, realizing this necessity more than the younger men do.

As to the matter of output, we do not find there is any trouble whatever. Four hours a week spent by the boy in the school is as a general thing made up by increased efficiency. It may not apply to the first year, when the boy is running a small lathe, or some small machine, but it does come in in the second or third year.

Apparently the system is having a good effect on the shop men, as we have had more interest in the night schools since this system has been started. We did not have so large an attendance before, and the foremen are attending these classes now more than ever.

The attitude of other roads is mentioned. I believe everybody agrees that you cannot make a much better investment than to spend a little money on educating the apprentices, no matter what the size of the road may be. A small road might not want to go to the expense the New York Central has undertaken, but practically the same system can be carried on with very little expense. Smaller roads can obtain the lesson papers from some outside source, and a very little attention on the part of the officials would give splendid results.

It occurred to me when I got a copy of this paper that it might be of interest to know what the boys thought about it. One thing is to prescribe a course of medicine for a man, and another, to know how it works. I wrote to the boys in the second and third year and asked them to say what they thought of the apprentice course, whether it was a benefit to them or not, and asked them not to sign their names to the papers, as I wanted them to say only what they wished to say, freely and frankly. Part of one of the letters, which is quite characteristic, is as follows:

"The drawing school is going to make a better machinist of me than I would have been without it, because I learned there lots of things concerning the work which I would never thought of myself. I know that I shall, when my term is up, feel more confident and more satisfied with myself than I would if I had not received the drawing school training."

Dr. W. F. M. Goss (Purdue University).—No more important matter awaits the attention of the management of American railways than that of training men for its service. For years past, large sums of money have been spent in the improvement of tracks, in perfecting equipments and in the elaboration of problems involved by the operation of trains. But the effectiveness of these improvements in material things, must, in the long run, depend upon the degree of intelligence which controls their use. If the training of men has kept pace with the increased complication and higher efficiency of the material equipment employed, there will be no lack, otherwise there will be a condition of unbalance, as of a refined instrument in hands insufficiently trained to guide it. It takes time to improve an organization. In the matter of training men, it is less a question of to-day's efficiency than it is a matter of to-day's preparation for results which must be forthcoming to-morrow. This fact gives increased significance to the apprenticeship system of the New York Central Lines. The benefit cannot be immediate—it looks to the future. The plan which has been adopted is, I think, admirable. By beginning with the apprentice boys, it starts right, and, by giving systematic attention to the intellectual development of the apprentices, it proceeds along correct lines. I have no hesitation in saying that the railroad company projecting this system will receive large returns upon its investment; and I must add that the adoption of such a system well reflects the broad and progressive spirit which so often characterizes the acts of our worthy president.

As one from the college, I cannot refrain from calling attention in this connection to a lack of interest on the part of American railways in men from the college. In making this statement, I freely admit that the time has passed when a college diploma could be accepted as evidence of ability. Not all college men are intellectual giants, but the fact remains that among the graduates of our colleges are men who have good physique and sound minds, men who are able and willing to work, whose purposes are strong and whose characters are fine. The manufacturing interests of our country recognize this fact. Each year, in March or April, representatives of many of these establishments visit the colleges in their search for men whom they can start at the bottom of their organizations. In the exercise of their choice they are painstaking and discriminating. These manufacturing industries are not more important to the welfare of our country than the great railway corporations. They probably have no greater need of young men of superior quality than have the railroads. Nevertheless, it is my observation that railway companies do not ordinarily show an equal interest in recruiting their staff.

Mr. W. B. Russell (N. Y. C. Lines).—It was predicted before we started this plan that the apprentice system would not last three months, and it probably would have failed, at least on the educational side, if the ordinary methods of instruction had been followed. The apprentice, as we find him, is not a man who can appreciate college methods, or any adaptation of college methods to his case. High school training will not fit him. It has been necessary to start fresh from the beginning and develop a system of training to fit the special need we have here in America.

The two features of the work are the drawing courses and what are called the problem courses. Drawing courses for apprentices are nothing new, but our method of teaching drawing is different from anything I know of in this country. The geometrical work, which ordinarily takes a year or two in most evening schools, is omitted entirely. The boy starts immediately on practical work, being called upon to deal with actual conditions. The geometrical knowledge may be necessary, but is introduced as it is wanted. We do not teach him the principle and then let him apply it, but teach the application and the principle at the same time, the idea being to keep in view at all times the practical result to be gained. In our public school systems we have overlooked many important points. This work must go much slower than ordinary school courses.

The apprentice does not appreciate a lecture; it is wasted. The work must be individual, no system of teaching which requires the same standard from each apprentice will fill the bill. The standard must be an individual one; the quantity of ground to be covered is not an element in this. All of our public schools and high schools are intended to train for college, the high schools especially teach with that end in view, and our public school training is drifting into that line. In the case of the work we are doing we have no college requirements to meet. What we are trying to make in this instance are men, and the best method does not consist in the quantity of work they cover, but how they cover it.

With the apprentice no class work can be undertaken because the classes, which are limited to 24, may contain a boy just starting as an apprentice and another about to finish. By means of

blue print sketches it is possible for one instructor to keep each boy in the class on a different problem. These sketches give the apprentice full instructions as to what he is to do and how he is to do it, saving the instructor from the necessity of repeating details to each boy. The instructor is present to oversee the work. If the work was being carried out in a single shop, where the mechanical engineers and officers could father it and watch over it, many things could be done which it is impossible to do with schools widely scattered. Our schools are so located that it is impossible in some instances to visit them oftener than once a month. Nevertheless under these conditions the educational features work out successfully.

The second part of the work, the problem course, is unique in this respect, that we have nothing to fall back upon. As a matter of fact we have had to leave out everything in the textbooks and have found it impossible to use them. There is nothing in this country at the present time to fit the needs of the apprentice, and it has been necessary to start from the beginning. The practical problem is first stated and solved, then followed by a sufficient number of similar problems to cause the principle to take root. In every-day life we do not have a classification of arithmetic, geometry, etc., but the problems are a combination of these subjects. It would be impossible, however, to take problems directly from the shop as they come up and give them to the apprentices, but it is possible to select problems that will slowly increase in difficulty and thus use actual shop problems in instructing apprentices. In doing this there is no subdivision into arithmetic and algebra. If the problem requires algebra for its solution the necessary amount will be introduced, but without the apprentice knowing it. At one of the points the boys found that they were working problems similar to those in the fourth year of the high school course and the result of the discovery was that they became frightened and did not do the work so well.

Our aim in connection with these problems is to make them fit in as closely as possible with the boys' daily work. We get the problems from the instructors and mechanics, and pick them up wherever we can, using all the illustrations possible from actual road conditions, taking the data of a problem from the local division of a road, if possible.

I want to emphasize the matter of the personal touch between the apprentices and the instructor, and between the instructors and the heads of the apprentice department. This statement may sound queer from an educational standpoint, but it has been clearly demonstrated that the personality of an instructor counts for much more than his actual knowledge. The personal touch is the key to the situation. If the instructor does not know his pupil well enough so that the pupil will interrupt him in order to ask a question—if the relations between the instructor and the apprentices are not on such a footing that they feel at liberty to do this—he is not a good instructor. In many cases instructors are called by their first names by the apprentices, which shows how closely they work together. Many of our best instructors find it necessary to study at night in order to keep ahead of their classes. They make the best instructors because they can look at a subject from the apprentice's standpoint, and can bring the apprentice up step by step, appreciating all of the difficulties because of the fact that they are studying themselves.

Referring to Prof. Hibbard's remarks. The state cannot undertake the whole of this educational work. It is true that our public school system is not preparing the right kind of men for apprentices. It is more and more evident that even high school graduates who come to us are deficient in many respects. In public school work it would be impossible to pick illustrations to suit in a single class all of the trades which the school should fit for. This is noticeable in evening classes, where the same class may contain a marine engineer, a locomotive engineer, a stationary engineer, a hardware clerk, and possibly a clerk from a drygoods store.

In regard to the college faculty, and the advantages to be attained there, we have somewhat similar conditions in the fact of instructors visiting other schools, and it is arranged that at least once a year they will come together at one point. Shop visits are arranged for, and occasionally three or four instructors meet at one place to compare notes. The rivalry between the schools is very apparent and results in much good.

In regard to an understudy. We have now at most shops a man ready to step in and take the instructor's place. Since starting we have had at two schools three different instructors and yet the work has gone on smoothly. What at first promised to be our greatest difficulty—the securing of instructors—has proved to be an easy matter. We have no dearth of instructors, are rapidly educating our own and already have a number of men at various shops who are thoroughly qualified. In this connection the mechanical engineer's department is cooperating by selecting only such men for shop draftsmen as will be capable in time of making good instructors. At each point on the system there is at least one apprentice who can take full charge of the class for one or two weeks and in one instance a shop instructor carried the entire educational work for a month while the regular instructor was ill. This was possible because of the arrangement of the work.

We are endeavoring, as rapidly as possible, to bring in experimental work, not the kind the colleges have, because we are not trying to prove the laws of nature, but the kind that will demonstrate and show the reason for things. We have introduced at most points a small engine, because we have found many apprentices did not know what a valve was, nor understand the definition of lap and lead. It is not too much to predict that every machinist apprentice will be able to set valves before he graduates.

It was stated that this plan would not work where piecework was inaugurated. It will work equally well with either piecework or day work. We have it on both plans. Specialization and not piecework is to blame for the present lack of apprentices. This plan will also work in a small shop and we expect to put it in shops where there are only five apprentices. It may be in this case that the shop instructor and the educational instructor will be one and the same man, and will give only a small portion of his time to the apprentice work.

Provision is made in the apprenticeship regulations for allowance to be made for previous experience, and that covers the college man. We have no objection to his taking our regular apprenticeship course. Allowance in time and rate of pay can be made with the assent of the superintendent of apprentices, so that it is an individual matter.

The system was started so gradually that the question of enthusiasm was not a factor. There is more enthusiasm now than there was a year ago. We had a letter the other day from one school saying that there were 12 boys who were out of problems and it was up to us to supply them—that shows the enthusiasm. The statement was made that we were supplying leaders rather than mechanics. If Mr. Setchell could see some of our apprentices, for example, in the foundry and boiler shop, he would realize that some of them, at least, would never become leaders. *It is not our intention to educate apprentices out of the trade but in the trade.* We aim to reach the rank and file—the geniuses will take advantage of the conditions created and take care of themselves. The educational courses are not designed for high school graduates, but for the average apprentice, as we find him, frequently a young man who cannot tell how many sixteenths there are in an inch, but who may develop into a good workman in the shop. It is true that we are supplying draftsmen for some parts of our road, but this is a part of our plan, as when we find a man adapted for the drafting room it is to his interest and the company's interest to place him there.

Prof. H. Wade Hibbard.—In the absence of any one from the Pennsylvania Railroad being in the room just at the moment, I beg to read a half page from a recent number of the *Engineering Magazine,* in connection with an article entitled "A Railroad University. Altoona and Its Methods." "During the latter days of February, 1907, the city of Altoona added to its educational facilities a railroad high school, which is the first institution of its kind in the United States. Its progress may mark the beginning of a new era in education, if other industrial corporations see the advantages of forming such a working partnership with the public schools as the Pennsylvania Railroad has made in Altoona. The industrial department of this high school is fully equipped and all bills are paid by the railroad company. The department has nothing in common with manual training. A four years' course is planned, beginning with mechanical drawing and ending with machine design. The creation of the department is the result of a desire on the part of the railroad to discover a way to combine its needs for trained employees with the aim of the public school authorities to turn out young men ready to earn a living."

"A drawing room, carpenter shop, forging room, a wood and metal working machinery department—all equipped with modern tools—together with the expert instruction to be provided, will enable the school to give students advantages heretofore enjoyed only by pupils of the best technical colleges."

"Graduates of the Altoona high school will be fitted to go directly into the Pennsylvania shops on a footing between the regular apprentices who, as a rule, entirely lack training, and the more mature apprentices who are graduates of technical colleges. The railroad's return on its investment is expected in the way of better educated employees."

I would like to say in closing that I said yesterday no word with regard to the place of the graduate of the technical college. Some one met me after the meeting and said: "Why didn't you jump on this scheme; the New York Central is not going to take any more of your boys who graduate from your engineering college onto its lines." I said to my questioner, "You are entirely mistaken." I have talked with these people about this matter, and as an illustration told him that one of my boys who will graduate next week, who applied to Mr. Cross and told him he was going to graduate, and that he had also had some practical experience working in railroad shops in the summer time, and they said to him, "We will allow you two years for your educational experience, and summer vacation shop experience and ask you to serve two more years in this apprenticeship course." That is fine—what I believe in exactly, and what most of you gentlemen believe in.

I am getting tired of the words "special apprentice." I am getting tired of having a college man think he is going to be mollycoddled after he gets out of college. We do not want to mollycoddle him in college, and certainly you do not want to mollycoddle him after he gets out of college. I would like to see the graduate of the engineering college take a regular apprenticeship course, learn the trade, and having that foundation he can take care of himself and show whether he is useful to his employers for promotion later on.

Mr. J. F. DeVoy (C. M. & St. P.).—I desire to speak of the system which was inaugurated some six years ago by the present superintendent of motive power, Mr. Manchester. There had not been up to that time any particular line of work mapped out for apprentices, and we were called together to formulate a plan. Some parts I wish to speak of, particularly that relating to the teaching of drawing. You are doubtless aware that in the western country there are a good many isolated roundhouses in which perhaps it might be difficult for the New York Central system or that advocated by them to be worked out with a great deal of satisfaction. Therefore it was decided that the last three months, or at any time at which it could be done, the apprentices should be sent to the Milwaukee shops, the principal shops of the road, to serve two months in the drawing room.

Mr. F. P. Roesch (Southern).—I would like to say that there has been inaugurated in the Spencer shops of the Southern Railway during the past few months, a system which, while it is modified somewhat, is practically on the same lines as laid down by Mr. Cross. We had some difficulty in getting the boys to take advantage of it, or inducing them to come into the school room. The principal trouble we found was due to the fact that most of the apprentices possessed only the rudiments of an elementary common school education, and for this reason did not realize the benefit that they would obtain from a higher education, or from taking advantage of the opportunities offered; but I am glad to say that we have overcome that to quite an extent. The boys are instructed during the working hours, come into the class room in their overalls, and, as Mr. Cross has stated in his paper, their thumb-marks are found on their lessons. They are taught all the elementary branches, as well as the higher branches. We find that with some of the boys it is necessary to commence at the beginning, to teach them the A, B, C's. From that on they are taught drawing, arithmetic, some of the elements of geometry, although not in a regular way; they are taught the strength of materials, what is the minimum cutting speed of the different steels and tools. The maximum cutting speeds we allow them to determine for themselves, and we find they are doing pretty well at that. We found that the best way to arouse enthusiasm in those who did not care to take advantage of this schooling was to allow those who were more advanced to make the shop drawings or shop sketches, signing their own names to these sketches. These sketches are of course checked by the instructors. When a few of these sketches are brought among the workmen and among the other boys, they question: "Did Billy Dunn make this sketch? Where did he learn it?" "Over in the school room." So now, not only the apprentices, but some of the mechanics and some of the helpers, have asked for the privilege of instruction, the blacksmiths and the car men are coming in.

C. A. Seley (C. R. I. & P.)—This system, as outlined in the paper, has appealed to me especially in regard to its directness of method. That which is taught in the colleges and schools is necessary for the rounding out of the education perhaps in various ways, but what this thing is for is to educate the rank and file. You cannot keep down the boy who has it in him to be a future master mechanic. You cannot make master mechanics by education. The issue has been raised, perhaps not on the floor, but in the minds of a good many, between the education of the technical schools and colleges and of the shop system. Unfortunately, I did not have the opportunity of a technical education, and I cannot speak from that side of it as well as I could otherwise, but I know from my own experience in handling men that each has to be considered as an individual, and he that has it in him cannot be kept down. The rank and file of mechanics in our shops, as every motive power officer knows, have deteriorated, and this is the best method that I have seen of raising the standard, and it will provide, as the paper has said, for some foremen, and perhaps some superintendents of motive power.

Mr. C. W. Cross.—In answer to Prof. Hibbard, I will say that our efforts are directed to the moderate advancement of a large number of young men, instead of the high advancement of a few. As has been mentioned, the genius will take care of himself in the race for advancement, as he always has done. There is no conflict between the training of the practical young man and the man from the college, but rather a co-relation between them. These young men are given a time allowance on their course for previous experience in school shops, and are considered perfectly able to take care of themselves in competition with others who have not has as good educational advantages as they have enjoyed.

Mr. Pratt mentioned the preference of the majority of young men for certain trades and the difficulty in obtaining desirable young men in other trades. This has been overcome to some extent by paying a higher rate of pay in some of the trades.

In reply to Mr. DeVoy, I would state that it is our practice to have apprentices transferred from one shop to another, also from one drawing room to another, to give them a more general experience and to develop initiative. We all know that when a boy serves his time at one shop and stays there after completing his time, he is looked upon as a boy, no matter how old he is, but if he goes to another shop he becomes a man immediately.

THE EFFICIENCY OF THE WORKER AND HIS RATE OF PAY.

TO THE EDITOR:—In an article of descriptive and analytical criticism of the highest order, in your June issue, Mr. Clive Hastings has lucidly set forth the different modern methods of paying labor—day rate, piece rates and bonus on day rates. It was natural that having found the weak points of day rates, of piece work payments and of bonus rewards he should have felt inspired to evolve a method free from defects in the existing plans.

His major premises are:

Firstly, that an automatic adjustment of rates without interference by the management is desirable.

Secondly, that the wage fund shall remain constant however the shop efficiency may vary.

Thirdly, that the wage fund shall be automatically distributed to workers in proportion, not to their absolute, but to their relative efficiencies to each other.

As to the first premise, what is needed is a closer and constant study of varying conditions by the management, not additional excuses for shirking this essential duty. What would we think of a woman who, possessing a beautiful head of hair, did it up most carefully once for all and then varnished it so as not to need to bother about it for a month? However carefully she may adjust her hair to-day, a neat woman will comb it and brush it twice a day, so that each individual filament may be without fail straightened out with respect both to itself and its surroundings. Each individual in a shop requires at least as much attention as a hair and it rather seems as if Mr. Hastings proposed to dispense with combs and brushes and use varnish.

The second premise, that the wage fund shall remain constant however the shop efficiency may vary is in fact the contention of many labor organizations, with the direct result of grading down in efficiency instead of up. If shop efficiency increases the owner can afford to pay increased wages and, as experience has proved, will gladly do it. If shop efficiency goes down it is so tremendously expensive that the owner must remedy conditions. While Mr. Hastings does not propose to do away with a record of different men's efficiencies and of shop efficiency as a whole, he does propose to free the owner from any obligation to pay for higher efficiency even if brought about by extraordinary individual or collective effort.

Thirdly, even in piece work and in that form of bonus which gives no bonus unless a certain minimum speed is attained, the workers combine to condemn the extra fast worker and the pressure is so great that he drops down to a permitted maximum. Mr. Hastings proposes that the man who does more than the average number of pieces shall be paid for the extra number, not by the shop owner who benefits, but by paying less to the man who does not reach standard. I fear the plan would be unpopular and that each man would get busy seeing how little he could do instead of how much.

HARRINGTON EMERSON.

LOCOMOTIVES SHOULD SUIT CONDITIONS.—In some instances trouble has been experienced with modern heavy locomotives, because of the continued use of methods and designs suitable only to the light power formerly employed. With the continued use of heavy engines, however, these faults are now being avoided. Cases may also be cited where engine failures have been frequent owing to the use of light locomotives which formerly did efficient work, but are unable to meet conditions as they exist to-day. Such failures have been rectified by the introduction of modern power.—*William Penn Evans before the Pacific Coast Railway Club.*

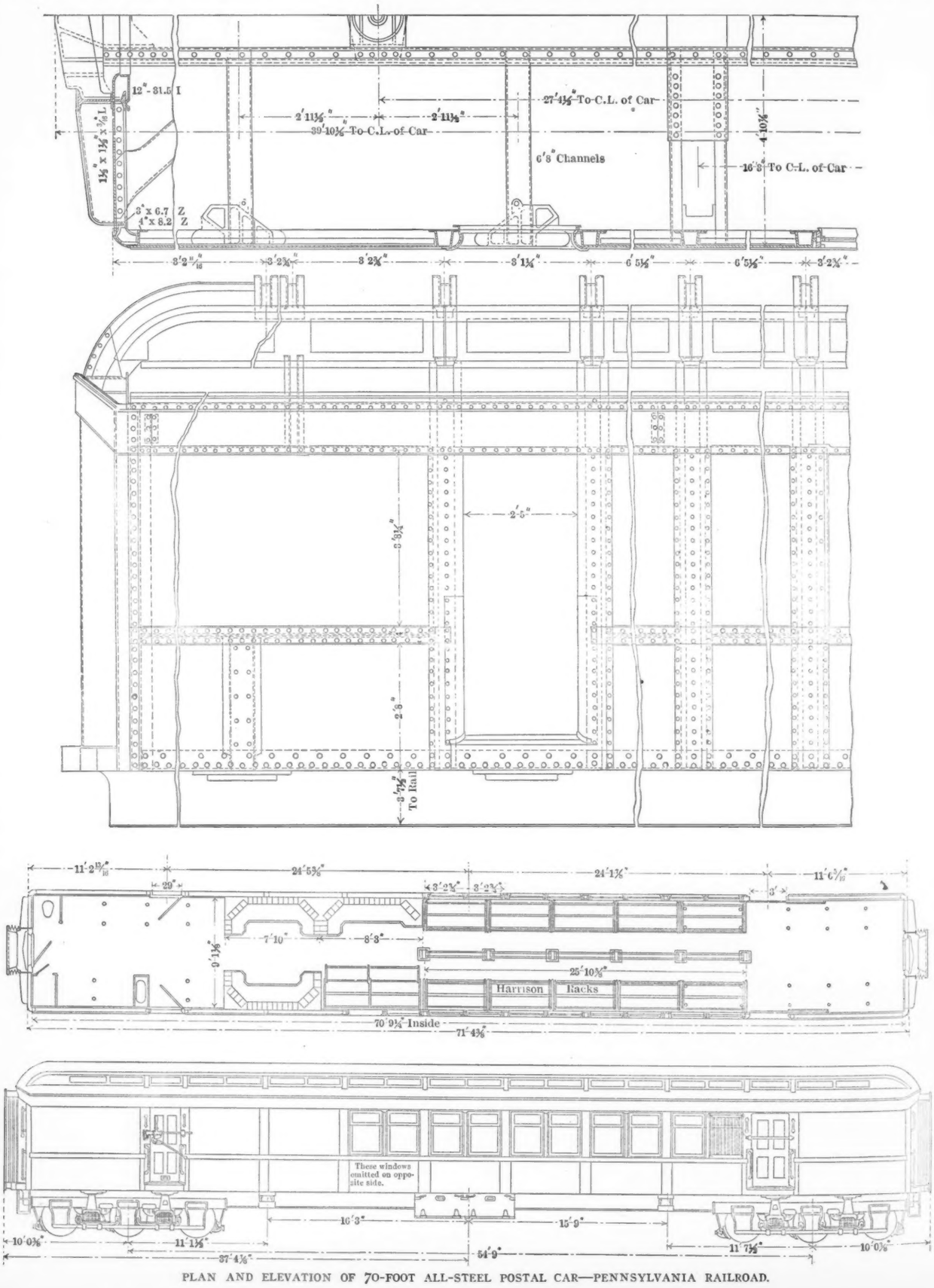
ALL STEEL PASSENGER SERVICE CARS.

PENNSYLVANIA RAILROAD.

POSTAL CAR.

These cars, which follow very closely the general principles used in the passenger coach, were briefly described and illustrated on page 136 of the April issue of this journal. At that time, however, drawings were not available and the description of the general structure will be repeated. Reference should be made to the previous article for views of the exterior and interior of the car and of its framing.

These cars are 70 ft. long, inside measurement, or 10 ft. longer than the present standard postal car. This extra length is used



PLAN AND ELEVATION OF 70-FOOT ALL-STEEL POSTAL CAR—PENNSYLVANIA RAILROAD.

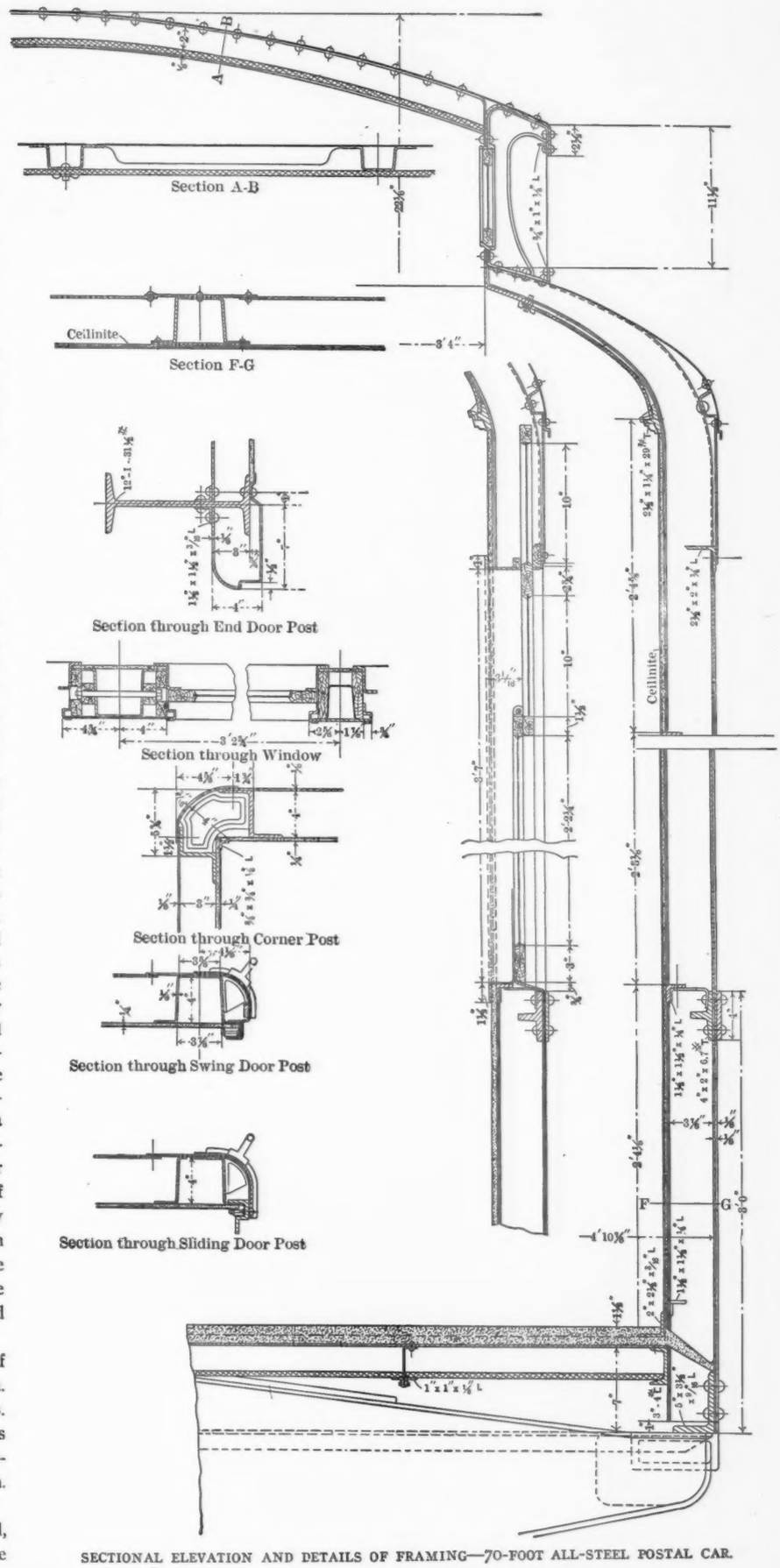
for storage space, thus giving the car a storage space at either end and placing the sorting and distributing sections in the center.

The underframe, which is practically identical with the 70-ft. passenger coach, with the exception of the modifications necessary on account of the omission of the vestibule and side steps, consists of two 18-in. I-beams, with ½-in. cover plates top and bottom, thus forming a box girder center sill which is set at a height above the rail permitting the draft gear to be enclosed in the girder and eliminaing the necessity of auxiliary draft sills. The whole weight of the car is carried on the center sills, being transferred to them by the end sills and by two cross bearers which are placed about 19 ft. from the end sills and about 32 ft. apart. These are made up of pressed steel shapes, with cover plates top and bottom. No body bolsters are required in this design and the center plate is fastened directly to the center sills and the side bearings to the side sills.

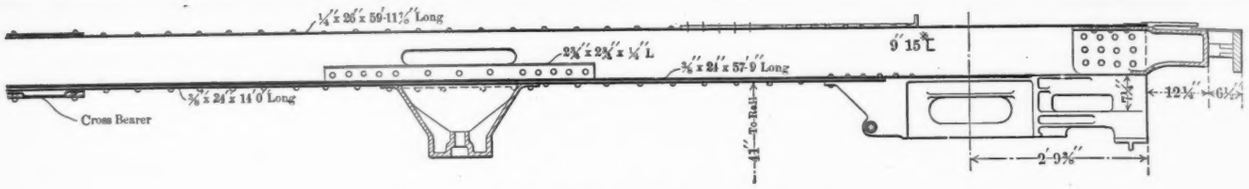
The superstructure is the same as that used on the passenger coaches with the exception that the belt rail is a flat bar instead of a formed section and is reinforced with a T-section between the posts. The end structure also differs somewhat from the passenger coach and is provided with two 12-in. I-beam door posts set with the web parallel to the sides of the car and securely fastened to the end sills and the end plate in such a manner as to make it practically impossible for the superstructure to be swept from its underframe by the adjoining car in the event of a collision. The side posts are of sheet steel pressed in channel section with the edges flanged out to connect with the side sheathing, thus forming a box girder structure. The side posts are narrowed down and bent inward at the top, forming the lower deck carlins. They are connected at the upper ends to the combined deck sill and plate formed of a sheet steel member pressed into a special channel section. The openings for the deck windows are cut in the web of this member, which is reinforced by malleable iron posts of special design between the window openings. The upper deck carlins are of a structure similar to the side posts, being secured to the upper flange of the deck plate.

The side and roof sheathing is of steel plates, the roof being 3/32 in. thick and the side ⅛ in. in thickness. The inside sheathing below the eaves is of 1/16-in. steel plate to the unexposed face of which is cemented 3/16-in. asbestos.

All of the interior furniture is of steel, and conforms to the regulations of the post-office department. The letter cases are built up of steel plates and wire and the larger cases are made of 1/16-in. sheet steel reinforced with angle irons. This car contains but 370 lbs. of wood, is lighted by electricity and heated by steam. It weighs 128,000 lbs.



SECTIONAL ELEVATION AND DETAILS OF FRAMING—70-FOOT ALL-STEEL POSTAL CAR.



CENTER SILL CONSTRUCTION—ALL-STEEL SUBURBAN CAR.

Suburban Car.

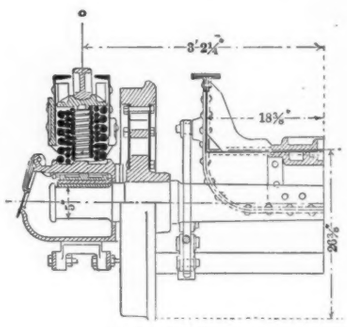
The general structure of this car is the same as for the heavier type of equipment, but the car is lower, shorter, and the space allowed each passenger is less than in the larger cars.

The underframe differs from the heavier equipment principally in the center sills, which in this case are formed of two 9-in. channels with a single ¼-in. cover plate on top and two ⅜-in. cover plates on the bottom. This arrangement is necessary in order to provide room for the motors on motor trucks, which may be used under these cars on electrified sections of the road. This construction makes it necessary to use auxiliary draft sills on these cars, the arrangement of which is shown in one of the illustrations. The center plate is of a special form adapted to reach the same trucks used under the heavier equipment. The upper structure of these cars corresponds very closely with the 70-ft. passenger coach.

Six-Wheel Truck.

The six-wheel truck which is used under the baggage and postal cars is designed along the same lines as were used in the four-wheel truck previously described.

The very deep center sills used on this equipment give the truck center plate but little clearance with the center axle of the truck and much care in designing was required in order to secure sufficient strength. The design adopted, as is clearly shown in the illustration of the truck, consists of built up steel girders resting on the two truck bolsters and carrying between them in the center a short connecting girder, for carrying the center plate, which is built up in channel shape with the lower



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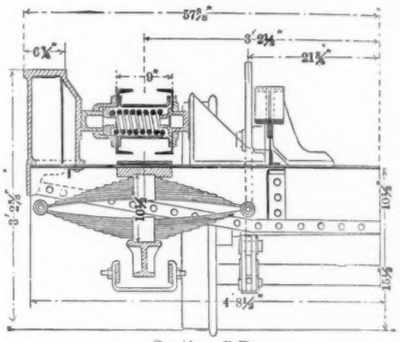

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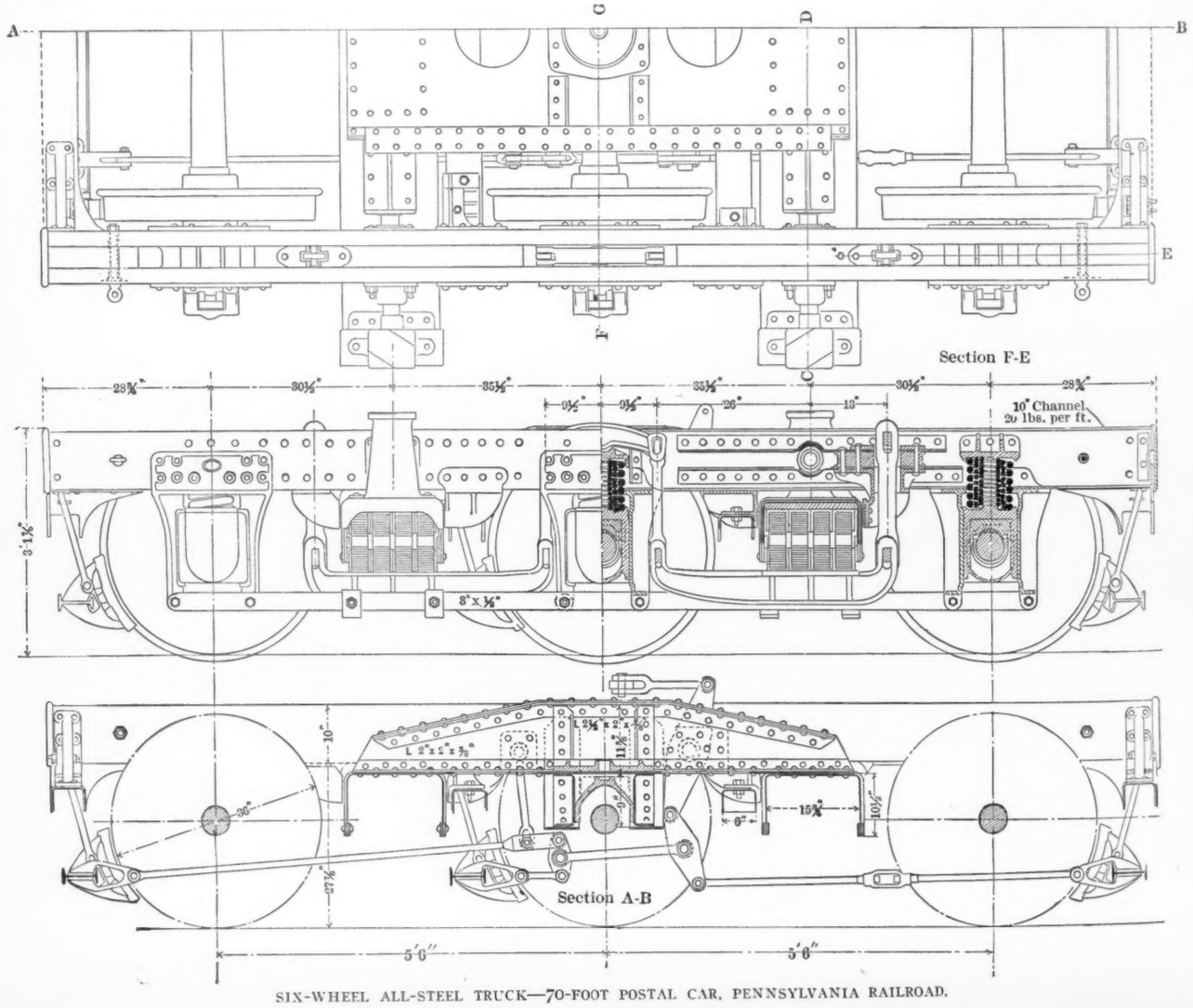
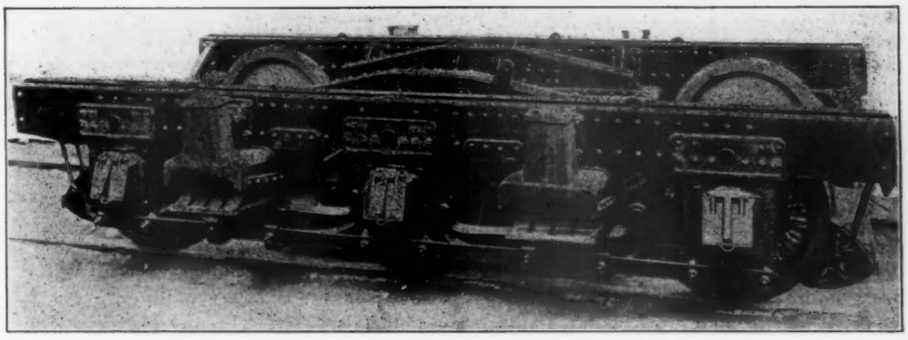


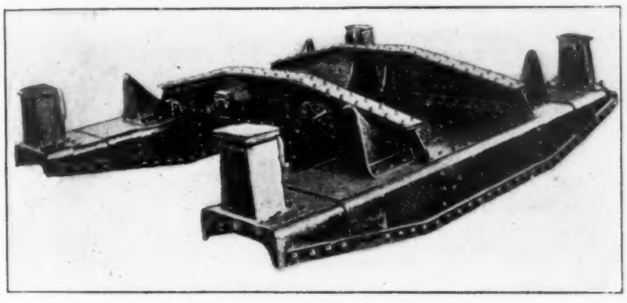
SIX-WHEEL ALL-STEEL TRUCK—70-FOOT POSTAL CAR, PENNSYLVANIA RAILROAD.

flanges spanning the center axle. A heavy horizontal steel plate binds and stiffens this whole structure as is shown in the illustrations. The two truck bolsters are of the same design used on the four-wheel truck and rest on sixteen elliptical springs, four at each end of each bolster. The wheel pieces consist of two 10-in. channels and are spaced and secured by four cross bars of a special pressed steel shape, being dropped down in the center to clear the center sills. The weight is transferred directly to the journals of the outer two wheels through the wheel pieces and the nests of coiled springs on each box in the same manner as for the four-wheel truck. The center wheel, however, receives its load through similar coiled springs, the spring cap of which is connected through a short equalizer by hangers to the 2: 1 equalizers on which the bolster springs rest. The shorter arm of these equalizers is connected directly to the wheel piece. In this manner each journal box receives 1/6 of the total weight brought to the truck.



SIX-WHEEL TRUCK, STEEL POSTAL CAR—PENNSYLVANIA RAILROAD.

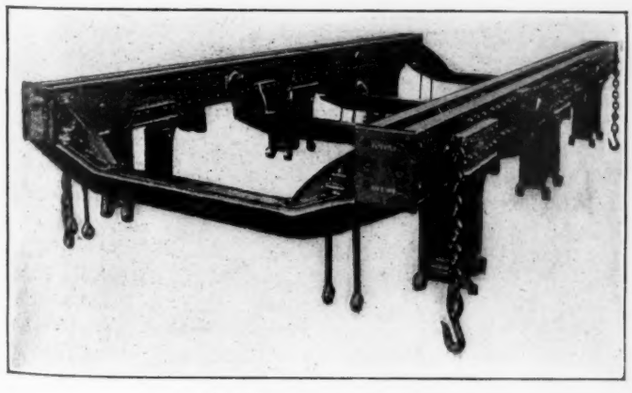
The bolsters have a spring centering device of the same type as used on the four-wheel truck and carry side bearings at their outer ends in a similar manner. This truck requires the use of brake beams, the connections to which, however, are made very close to the brake head instead of at the center as is usually done.



DOUBLE TRUCK BOLSTER—SIX-WHEEL TRUCK.

COUPLER AND DRAW BAR.

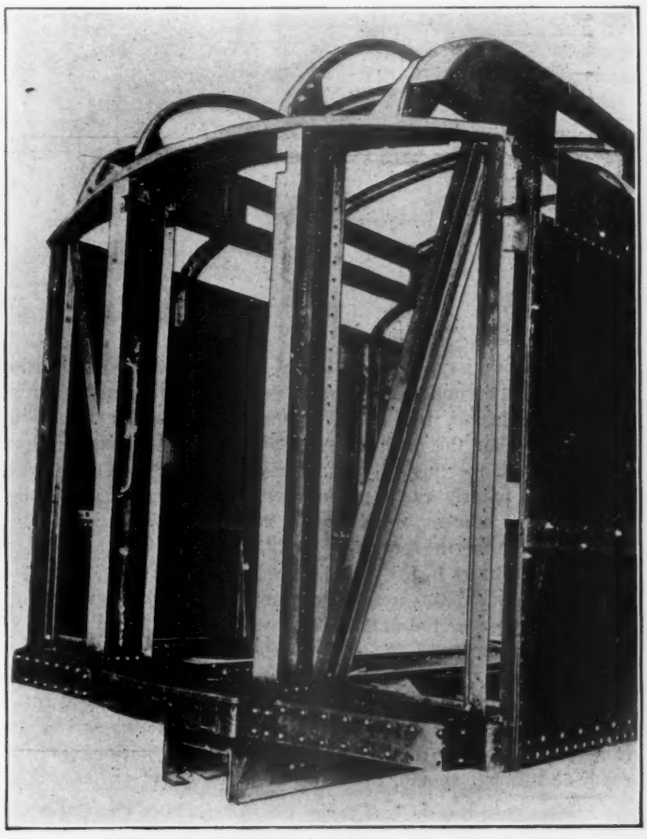
A special design of spring centering draw bar and coupler head has been applied to these cars. This will permit an 8-in. lateral motion of the draw bar on either side of the center without binding. The details of the design are shown in one of the illustrations. It will be seen that the draw bar is pivoted to the yoke at its inner end and to the coupler at its outer end. The socket in the coupler head in which the draw bar enters is broad enough to allow considerable radial movement of the coupler head. Within this socket pivoted around the same pin are two levers, the outer ends of which extend back and rest on a bearing fastened to the webs of the center sills. These two ends are held apart and against their bearing by a large helical spring. Both levers have another arm extending back and bearing on the opposite sides of a pin in the draw bar which is shown just within the ends of the center sills.



FRAME—SIX-WHEEL TRUCK.

The operation of the device is such that a movement of the draw bar as a whole operates through the pin just mentioned to one of the levers and the motion is then transferred to and resisted by the helical spring. The motion of the coupler head in rotating about its pivot is also transferred to these levers by the sides of the cavity in the head coming into contact with the lever and moving it against the resistance of the spring. Thus one spring acts as a centering device for both the draw bar and the coupler head.

To prevent trouble with the uncoupling connections when so large an amount of motion is provided for, they have been carried back to a bell crank pivoted around the inner draw bar pivot and by a series of bell cranks and rods, connection is made to the head and the uncoupling shaft from this point. The steam and air pipes are also connected so as to allow a certain amount of lateral motion and prevent interference with the coupler. They are connected, as is shown in the illustration, by a cast steel yoke having a bearing in lugs secured to the center sills and spanning the draw bar. Helical springs are arranged to keep this



BODY END FRAMING—70-FOOT STEEL POSTAL CAR.

yoke central except when the draw bar has moved a certain definite amount and strikes the yoke, carrying it along against the resistance of the springs.

A UNIT OF COMPARISON.*

By Geo. G. Yoemans.†

One of the gravest difficulties which confronts anyone who is attempting to exercise a general supervision over the supply department of a railroad, and to direct its operations without being intimately connected with the details of daily routine, is to determine definitely, and within reasonable limits, whether or not the total amount of supplies carried in stock is greater than it should necessarily be.

In other words, whether the interest charge on the money invested in supplies is warranted expense—and whether or not any portion of the amount so invested could be profitably released and diverted into other channels, where it would bring larger returns, without detriment to the service.

With the best intentions in the world the storekeeper is in the unfortunate position of being thrown in constant contact with those officials whose interests demand that there should always be "plenty" of everything available at a moment's notice, and while one of the fundamental duties of the position is to see that all reasonable demands of this nature are fully met, the daily surroundings of the storekeeper lead him to be on the safe side, and to frequently have more than "a plenty."

* * * * * *

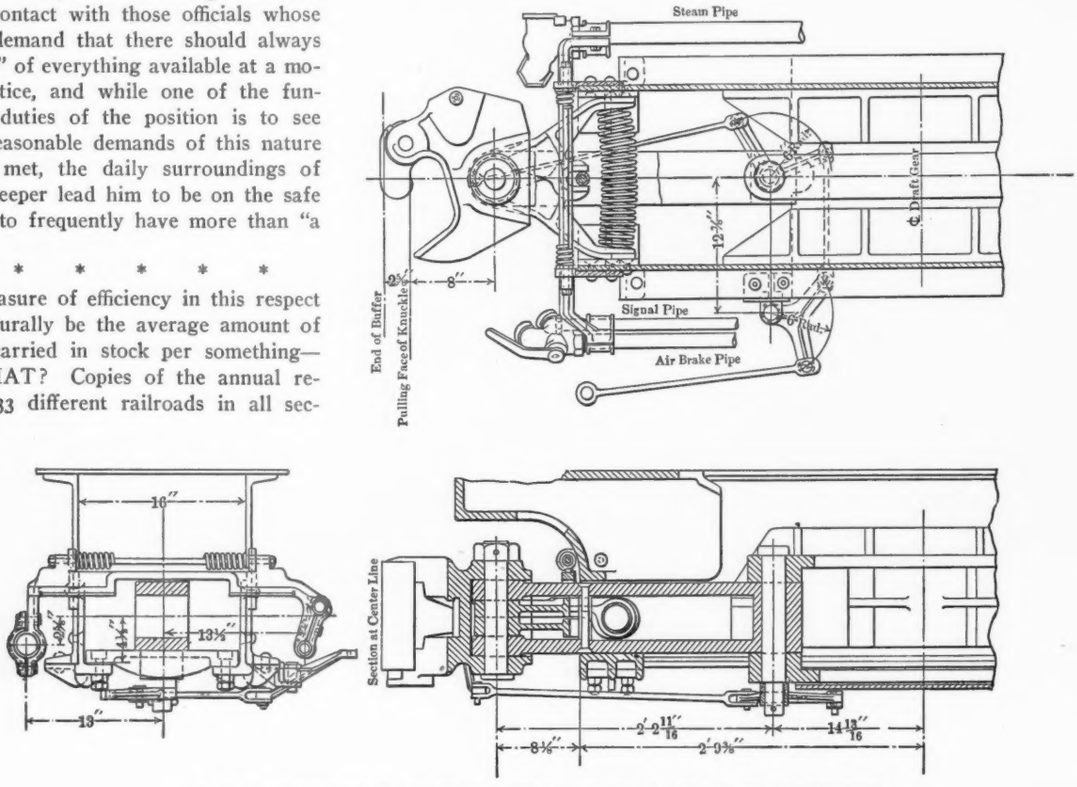
The measure of efficiency in this respect would naturally be the average amount of material carried in stock per something—PER WHAT? Copies of the annual reports of 33 different railroads in all sections of the country were obtained and a number of theories were considered and tested out in an attempt to reach a satisfactory conclusion, but in every instance we seem forced to the opinion that the only measure, which may be considered as approximately meeting all conditions, is the measure of work performed; namely the total number of tons moved one mile, and the total number of passengers carried one mile, added together; and that the percentage which the average amount of stock carried bears to the sum of these two factors expressed for convenience in "10,000 ton and passenger miles" may be considered as a guide to the amount of material necessary to be carried in stock, to meet the requirements of every-day operation.

* * * * * * *

The efficiency of the department must be judged upon the basis of the amount of miscellaneous stock material such as is commonly used in the ordinary every-day operations of the road and there should be no shelter of "extraordinary circumstances behind which the supply agent may take refuge.

Tested by this unit it is surprising to see what a wide variation exists among the leading railroads of the country in this respect, and while a portion of it is undoubtedly due to discrepancies of accounting, more is undoubtedly due to the degree of organization, methods, and efficiency which have been reached by the department in charge of this important branch of the service.

The total amount of money invested in material on the thirty-three roads under consideration is over one hundred and four millions of dollars. As between the two roads which, tested by this method, show the best and the poorest performance, the latter company, if its stock of material could be reduced to the same relative basis as that shown by the former, would be able to release over nine millions of dollars; and if its stock of material was reduced only to the average amount per unit shown as carried in stock by all of these lines, it would still be able to release over six millions of the money it now has so invested, the interest on which is in the nature of a fixed charge against its operation. If the total stock reported on hand by all of the thirty-three railroads could be reduced to the basis of the best performance over sixty millions of dollars would be made available for other uses.



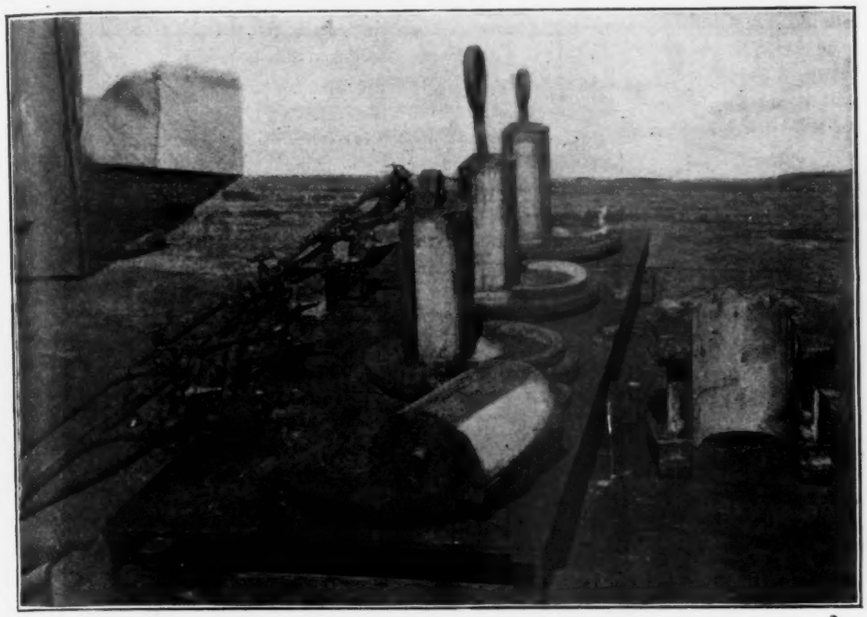
RADIAL COUPLER AND DRAWBAR—PENNSYLVANIA RAILROAD ALL-STEEL CARS.

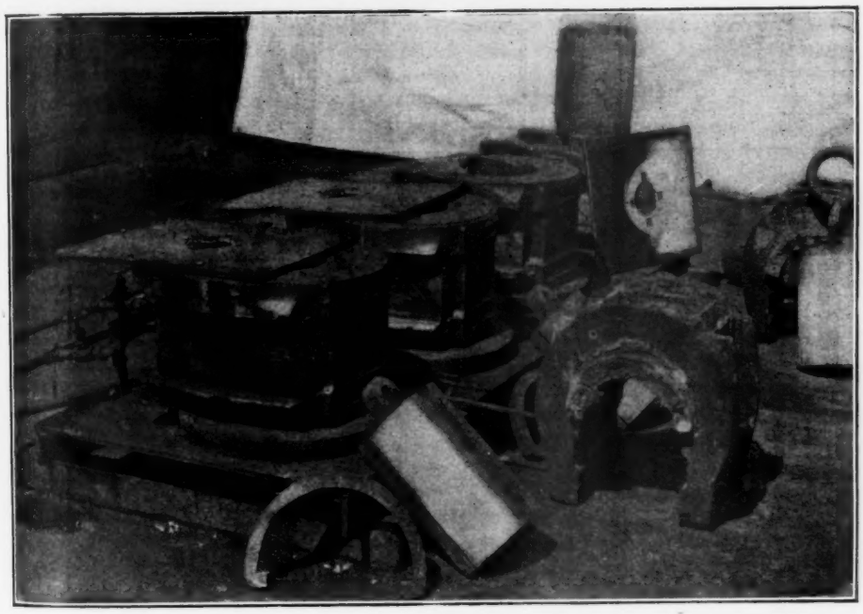
These are startling figures. I do not claim that they accurately represent actual conditions, but I do claim that they clearly point to conditions that actually do exist. Allow, if you please, fifty per cent. of these amounts for discrepancies in the accounting methods on which this comparison is based, and the remainder is of sufficient importance to awaken the interest of managing officials. Don't make the mistake of thinking that this is a little thing. Every hundred dollars intelligently released from unnecessary duty adds at least four dollars to the net income of the company at the end of the year, and the figures I have given indicate the number of times by which it may be possible to multiply that hundred dollars perhaps in your own department.

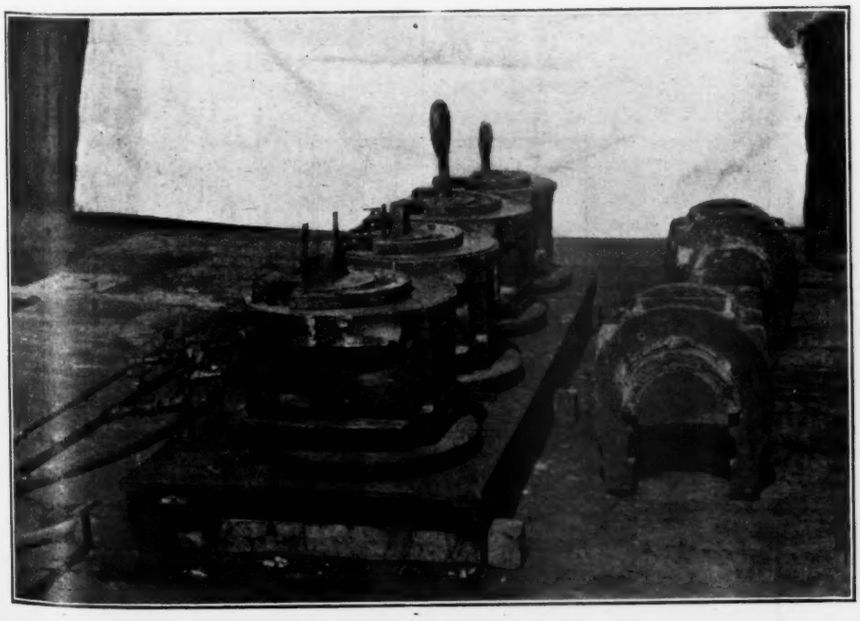
* Extracts from a paper read before the Railway Storekeepers' Association.

† Assistant to the President, Wabash Railroad.

The Pennsylvania Railroad has 45,496 shareholders, the average number of shares held by each being 137.







CASTING SHELLS AND HUB AND SIDE LINERS IN DRIVING BOXES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The practice of casting shells in driving boxes was introduced on the New York Central Lines, by Mr. John Hill, master mechanic on the Lake Erie & Western at Lima, Ohio. It is being followed extensively at Elkhart and Collinwood on the Lake Shore & Michigan Southern Railway and is giving very satisfactory results.

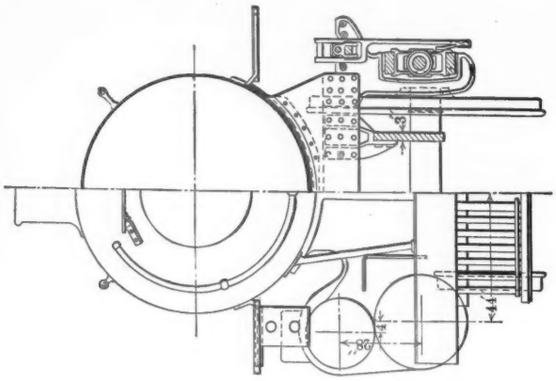
The apparatus used is shown in the accompanying photographs. Four cast iron plates, each of which carries a driving box, are placed on the iron table. A hole is bored in each plate to receive the pin on the end of the mandrel. The driving box is centered about the mandrel by tapered wedges driven into the slots in the mandrel and coming into contact with the sides of the box. After the box is properly centered the mandrel is lifted out and the end of the box and the upper side are partially covered with sheet iron pieces. A flame from the crude oil burner is then directed inside the box, heating and drying it out thoroughly and expanding the open ends from 5/16 to 3/8 of an inch.

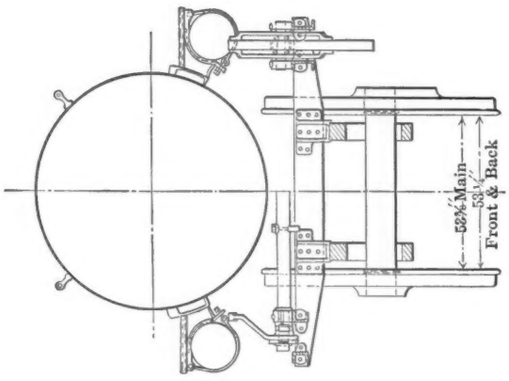
The mandrel is replaced and the wedges are driven home without changing the original position of the box. A wrought iron riser is then placed on top of the box, as shown. The metal is poured in at this top opening and as soon as it is set, but before the box cools, the riser and mandrel are knocked out of place. On boxes where it is necessary to use a hub liner the riser is made of a large enough diameter to equal that of the outside hub liner and the shell and the liner are poured at the same time and are in one piece. The box is then placed in an upright position. Cast iron formers are placed the proper distance from the shoe and wedge bearing faces and the side liners are cast in the same way as the shells, thus doing away with the necessity of machining the box or of riveting.

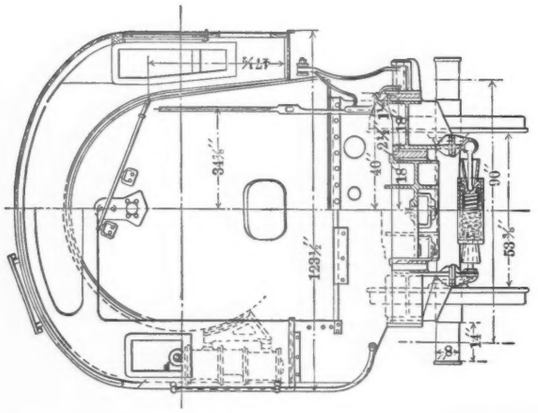
The crown of the box has five dovetail cuts in it into which the metal runs when the shell is poured. The function of these dovetails is to draw the brass close to the box. From 80 to 100 tons pressure are required to press the shells out of the box. These dovetails also make it possible to draw the open ends of the box together when the brass cools, which is exactly opposite from the action when brasses are forced into the box according to the usual method. The free opening at the top when the brass is poured allows the gases to escape and the metal mould cools the alloy instantly, preventing segregation. A fracture of the metal poured in this way shows a clearer, closer grain compared to the same metal poured in a sand mould. There is, of course, a

considerable saving of labor over the old methods. A number of heavy locomotives have been in service on the Lake Erie and Western with driving boxes fitted in this manner and the brasses have worn to 7/8 of an inch in thickness without becoming loose in the box. It allows the use of cracked boxes which could not be used with the pressed shell.

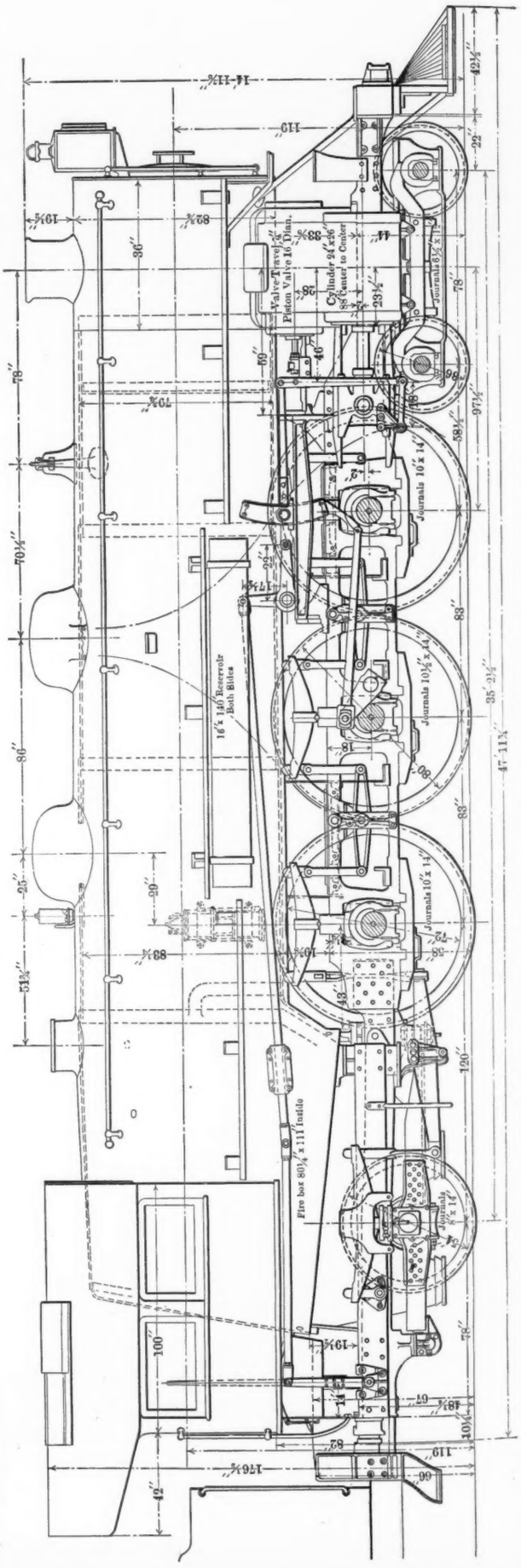
COALING DIRECT FROM CARS.—Where the quantity of coal handled is small and especially at terminal points where the engines lie over night and the coaling can be done by the hostler or watchman, coaling direct from the cars is the cheapest. This work can be helped by elevating the track, on which the coal cars stand, from two to four feet above the locomotive track.—*Report of Committee, Amer. Ry. Eng. & M. of W. Assoc.*



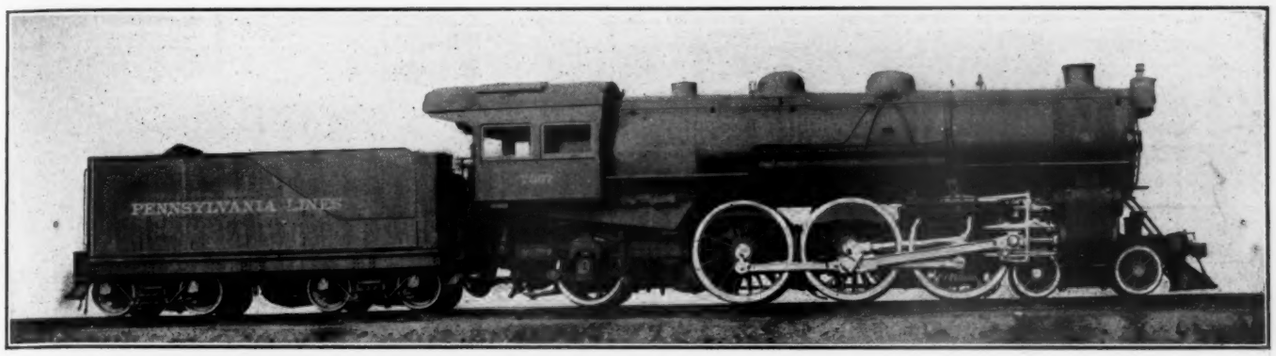




LABORATORY FOR TESTING EXPLOSIVES.—The United States Geological Survey, within a few weeks, will establish, probably in the Pittsburg district, an experiment station for the purpose of testing explosives used in coal mining, the ultimate object being, if possible, a reduction in the number of mine disasters resulting from gas and coal dust explosions. Miners' safety lamps will also be tested at this station, and explosive investigations will be conducted both in the laboratory and in the mines.



ELEVATIONS AND SECTIONS OF 135-TON PASSENGER LOCOMOTIVE—PENNSYLVANIA RAILROAD.



HEAVIEST PASSENGER LOCOMOTIVE EVER BUILT—PENNSYLVANIA RAILROAD.

LARGEST PASSENGER LOCOMOTIVE, 4-6-2 TYPE.

PENNSYLVANIA RAILROAD.

The American Locomotive Company has recently completed at its Pittsburg works a Pacific type locomotive for the Pennsylvania Railroad, which in point of size and weight exceeds any passenger locomotive ever constructed. It weighs 269,200 lbs. total, has 24 x 26 in. simple cylinders, a 79¾ in. boiler, 21 ft. tubes, 61.8 sq. ft. of grate area and carries 205 lbs. steam pressure. The tractive effort, because of the large drivers and lower steam pressure, is not as great as that of the 2-6-2 type balanced compound on the Santa Fe,* but exceeds all other passenger engines on our records. The accompanying table will permit comparison of the general dimensions and ratios of this and four other recent large passenger locomotives.

Road	P. R. R.	A. T. & S. F.	N. P.	L. S. & M. S.	Erie.
Type	2-6-2	2-6-2	2-6-2	2-6-2	4-6-2
Simple or comp.	Simp.	Comp.	Comp.	Simp.	Simp.
Total weight, lbs.	269,200	248,200	240,000	233,000	230,500
Wgt. on drivers, lbs.	173,550	174,700	157,000	165,200	149,000
Tractive effort, lbs.	32,700	37,800	30,340	27,850	30,300
Size of cylinders	24″ × 26″	17½″ & 29″ × 28″	16½″ & 27½″ × 26″	21½″ × 28″	22½″ × 26″
Diam. drivers	80″	69″	69″	79″	74″
Steam pressure, lbs.	205	225	220	200	200
Tot'l heat surf., sq. ft.	4,427	4,020	2908.8*	3,905	3,326
Length of tubes	21′	18′ 10⅛″	16′ 9″	19′ 6″	20′
Grate area, sq. ft.	61.8	53.8	43.5	55.	56.5
B. D. factor	590.	650.	720.	565.	669.
Tot'l H. S. ÷ grate area	72.	74.	67.	71.	58.7
Total H. S. ÷ vol. cyl.	326.	334.	294.	335.	277.
Tot'l wgt. ÷ total H.S.	61.	62.	82.5	61.	69.5

* Combustion chamber 3′ long.

The standard passenger locomotive of the Pennsylvania Railroad has been, for many years, the Atlantic type, of which there are several classes in operation. The largest of these, known as the E3D, has 22 x 26 in. cylinders, 80 in. drivers, 67 in. Belpaire boiler, and carries 205 lbs. steam pressure. The tractive effort at 85 per cent. boiler pressure being 27,500 lbs. It has Walschaert valve gear and piston valves.

These locomotives have been able to satisfactorily handle an eight-car passenger train over divisions where there are many difficult grades. However, as many of the passenger trains now require ten, twelve or more cars, making them altogether beyond the limit of the Atlantic type unless the weight on drivers was increased above practical figures, it was decided to design a Pacific type engine which would be able to handle the heaviest trains on these divisions. While but one of this design has at present been built it is expected that, after a careful working out of this one, more will be ordered.

The general features of the design will be evident from an inspection of the general elevation and the table of dimensions given below. A number of the details will be illustrated and separately considered in the next issue.

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Soft coal
Tractive effort	32,700 lbs.
Weight in working order	269,200 lbs.
Weight on drivers	173,550 lbs.
Weight of engine and tender in working order	409,200 lbs.
Wheel base, driving	13′ 10″
Wheel base, total	35′ 2½″
Wheel base, engine and tender	67′ ¾″

RATIOS.

Weight on drivers ÷ tractive effort	5.30
Total weight ÷ tractive effort	8.22
Tractive effort × diam. drivers ÷ heating surface	590.00
Total heating surface ÷ grate area	72.00
Firebox heating surface ÷ total heating surface, per cent.	4.65
Weight on drivers ÷ total heating surface	39.20
Total weight ÷ total heating surface	61.00
Volume both cylinders, cu. ft.	13.60
Total heating surface ÷ vol. cylinders	326.00
Grate area ÷ vol. cylinders	4.56

CYLINDERS.

Kind	Simple
Diameter and stroke	24″ × 26″

VALVES.

Kind	Piston
Diameter	10 in.
Greatest travel	7 in.
Outside lap	1 5/16 in.
Inside clearance	¼ in.
Lead in full gear	¼ in.

WHEELS.

Driving, diameter over tires	80 in.
Driving, thickness of tires	4 in.
Driving journal, main, diameter and length	10½ × 14 in.
Driving journals, others, diameter and length	10 × 14 in.
Engine truck wheels, diameter	36 in.
Engine truck, journals	6½ × 12 in.
Trailing truck wheels, diameter	54 in.
Trailing truck, journals	8 × 14 in.

BOILER.

Style	Straight
Working pressure	205 lbs.
Outside diameter of first ring	79¾ in.
Firebox, length and width	111 and 80¼ in.
Firebox plates, thickness	⅜ and 9/16 in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	343—2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	4,222 sq. ft.
Heating surface, firebox	205 sq. ft.
Heating surface, total	4,427 sq. ft.
Grate area	61.8 sq. ft.
Smokestack, diameter	22 in.
Smokestack, height above rail	180 in.
Center of boiler above rail	119 in.

TENDER.

Tank	Waterbottom
Frame	Steel
Wheels, diameter	36 in.
Journals, diameter and length	5½ × 10 in.
Water capacity	7,000 gals.
Coal capacity	11 tons

* See AMERICAN ENGINEER, Nov. and Dec., 1906, pages 434, 481.

ERECTING SHOP FLOORS.—Floors with a top wooden surface are much to be preferred, as they are more agreeable for the men standing upon them. This floor, however, must be protected from rot by a proper substructure. A recent specification called for the ground to be well tamped to a level 14 inches below the finished floor line and then covered to a depth of 6 inches with broken stone, the voids being filled with small stones and the whole being well rolled or rammed into place. This surface was to be liberally covered with hot coal tar, and after setting, it was to be brought to a level by one inch of sand and tar, the sand being heated and thoroughly incorporated with a mixture of two parts of coal tar and one part of coal tar pitch. On this were to be placed 3 x 4-inch yellow pine zinc-treated sills, the spaces between the sills being filled with tarred sand and packed while hot to a level with the top of the sills. Over this was to be laid a course of 2¾-inch treated yellow pine, this being covered with a layer of roofing felt, and finally a course of 1¼-inch hardwood boards. While such floors are expensive they are very permanent, and we have heard of cases where they have been in use for twenty or thirty years.—*Mr. G. R. Henderson at the New England Railroad Club.*

HARRIMAN LINES ALL-STEEL POSTAL CAR.

STEEL POSTAL CAR

HARRIMAN LINES.

In the January, 1907, issue of this journal there were illustrated the details of an all-steel 60-ft. passenger coach, designed and built by the Southern Pacific Company at the Sacramento shops. The same company has recently completed an all-steel postal car, which in general features of construction follows very closely the principles used in the passenger coach.

The underframe of this car consists of two 12-in. I-beams as center sills and two ½ x 3½ x 7 in. angles as side sills. These members are continuous between end sills. The center sills are trussed by two 1½ in. truss rods passing over the top of the bolsters and connecting to steel castings on the end sills. The center and side sills are tied together between the bolsters by 5 in. channels set with the web vertical and secured to the sills by 2½ x 2½ in. angles. These are spaced approximately 2 ft. apart. The sills are further tied together by the needle beams, which are built up of ¼ in. web plates and 3 x 3 in. angles into an I-beam structure. A ¼ in. cover plate passes continuous over the top of the center sills and a ½ in. plate forms a bottom cover plate and extends continuous between the side sills below the center sills. The underframe is stiffened by four sets of diagonal braces consisting of 5 in. channels arranged and connected as shown in the illustrations. The body bolsters are double and of cast steel and are constructed to fit around the center sills.

The side framing consists of 2¼ x 4 in. posts extending between the side sills and the plate, which is a 4 x 4 in. angle continuous the full length of the car. These posts are spaced as shown in the illustration and are stiffened by 2¼ x 4 in. angles set between and connected to each, forming the belt rail. Diagonal braces of 2 x 2 in. angles are fitted on either side of the door openings as shown. The end framing is composed of rectangular plates ¾ x 3 in. to which heavy angles are riveted and extend from end sill to end plate. The end door framing is constructed of two heavy angles forming a Z-bar and adding materially to the strength of the end construction. Further strength and stiffness is obtained by the placing of a 5/16 in. plate 20 in. wide horizontally across the car and securing it to the end and side plates.

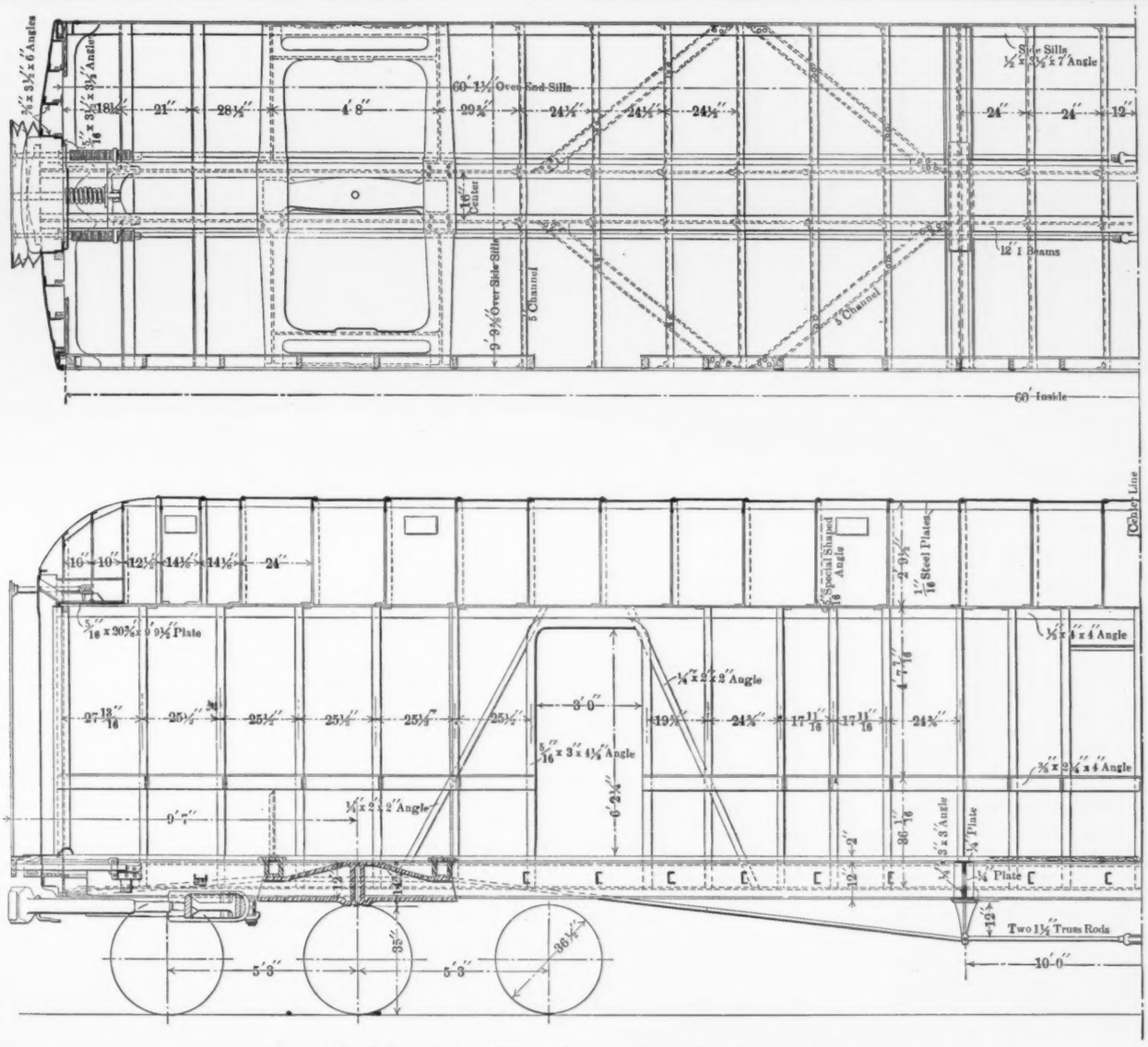
The shape of the roof is elliptical, the upper deck being dispensed with. It consists of carlines composed of 5/16 x 1¾ x 4⅝ in. angles formed to the proper contour and secured to the side plates. The outer roof lining is of 5/16 in. sheet steel, and the inner lining is of similar sheets, which are flanged on the edges and riveted to the carlines, thus forming panels 2 ft. in width. This construction is clearly shown in the view of the interior of the car.

The side sheathing is of 3/16 in. steel plate up to the belt rail and ⅛ in. steel plate above this. A letter board of ⅛ in. steel plate 12 in. in depth covers the joint of the roof sheets with the side sheets. The interior finish is of asbestos board secured to the wooden filling pieces fitted in the side posts.

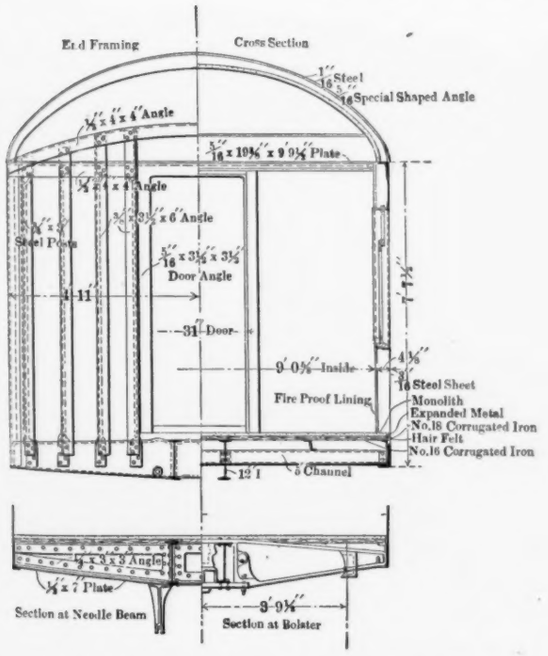
The flooring is formed of two courses of corrugated steel sheets, between which two courses of hair felt are placed. These rest on the center sills and longitudinal angle irons secured to the cross bearers and side sills. A monolithic cement floor is laid on top of the upper sheet.

The lighting is by electricity generated from the axle and the car is heated by direct steam, the system being fitted with an automatic temperature regulator. Cottier ventilators to the number of 14 are fitted in the roof. The car is carried on two six-wheel trucks of the usual Pullman type. The interior is fitted

INTERIOR OF ALL-STEEL POSTAL CAR.



FRAMING OF ALL-STEEL POSTAL CAR—HARRIMAN LINES.



with pouch racks, sorting boards and pigeonholes to suit the Government specifications. The car weighs 116,900 lbs.

The Union Pacific Railway has also recently turned out of its Omaha shops a steel postal car of a design practically identical with the one above described. The service of this car was so satisfactory from the beginning that it has been decided to build thirty-four more of the same type. The contracts for these are now being placed.

VARIABLE SPEED MOTORS ON MACHINE TOOLS.—For driving machinery, motors of variable speed are generally required for individual applications and constant speed motors when a group of tools is driven through a section of shafting. Motors can now be obtained operating upon a single voltage with a speed ratio of 3 or 4 to 1, and in some cases even greater; but for railroad purposes we think that a change ratio of 2 to 1 is generally sufficient, the additional variations being made by mechanical means. This enables one to use motors of a lower price than where a large speed ratio is considered important. It is perhaps only necessary to have the large variable speed ratio where a piece of work has to be faced in a boring mill from a large circumference down to a small central portion, and as such classes of work are rare in locomotive shops there seems to be little absolute need for the higher speed ratios. Three-wire and four-wire multiple-voltage systems have been installed, but we doubt if there is sufficient to pay for the complication in wiring over the single-voltage method of speed regulation by field weakening. Alternating current motors are very satisfactory for constant speed work, but it is often thought advisable to limit the power current in one building to either the direct or the alternating, in preference to having a mixture of the two. —*Mr. G. R. Henderson at the New England Railroad Club.*

(Established 1832).

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Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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COMPARATIVE COST OF MAINTAINING STEEL AND WOODEN CARS.

Through the courtesy of Mr. J. Kruttschnitt, director of maintenance and operation of the Union Pacific System and Southern Pacific Company, we are enabled to present the following comparative statement of the cost of maintaining steel and wooden cars. This statement is for cars of approximately the same age and capacity and covers a period of 2½ years, from September 1, 1904, to February 28, 1907.

Kind of car.	Av. No. of cars.	Total cost of repairs.	Av. cost repairs per car per month.
Steel Cars:			
Ballast	460	$71,291.81	$5.17
Box	2,304	108,323.29	1.57
Coal	1,594	165,959.57	3 47
Dump	300	39,322.92	4.37
Flat	2,289	72,024.30	1.05
Furniture	297	32,198.04	3.61
Gondola or Ore	1,419	134,019.10	3.16
Oil	871	261,613.43	10.01
Stock	1,693	55,908.34	1.10
Total	11,227	$940,660.90	$2.79
Wooden Cars:			
Ballast	457	$65,560.89	$4.78
Box	6,247	735,405 53	3.92
Coal	127	14,329.81	3.76
Flat	512	15,699.75	1.02
Furniture	278	61,999.51	7.44
Oil	247	96,910.90	13.05
Stock	2,700	291,940.19	3.61
Total	10,568	$1,281,846.58	$4.04

Of the so-called steel cars the ballast, coal, dump, gondola and ore and oil cars are of all-steel construction; the box, furniture and stock cars have steel underframes; one hundred of the flat cars are all-steel and the remaining 2,189 have wooden floors. The high cost of repairs for the oil cars is due to the fact that alterations which it was found necessary to make on these cars shortly after they were placed in service were charged to the repair account.

CONVENTION NOTES.

The attendance at the conventions was larger than ever before. The meetings were especially well attended and the proceedings were followed much more closely than usual. Care had been taken to eliminate all disturbing noises and the speakers were able therefore to make their remarks more effective than usual. Usually near the close of each convention the attendance begins to fall off, but this year it held up to the very last moment. The exhibits, both as to general appearance and in detail, were far beyond any of the previous ones. This fact was appreciated by the railroad men present, most of whom found it necessary to devote a considerable amount of time to them.

* * * * * * *

It is unfortunate that more younger men did not take an active part in the meetings. Very few of them participated in the discussions. A systematic effort should be made to "line them up" and to develop them for more effective work.

* * * * * * *

The executive committees should see to it that some attempt is made to have the reports in the hands of the members earlier than usual before the next conventions. As it is, and has been in the past, the reports are received by the members too late for them to make a careful study of more than a very few of them before the conventions and they are thus not in a position to discuss them intelligently. The reports should be sent to the members at least 30 days before the convention. Such reports as are not received in time should be held over for a year and the committees should be censured.

Under present conditions the members do not have time to prepare a carefully thought out discussion of the papers in which they are specially interested, but speak on the "spur of the moment." Because of this they do not always succeed in making their meaning very clear and often considerable time is wasted because in the hurried reading of a report they may overlook im-

portant parts or fail to grasp the import of the paper as a whole. Not only should the reports be issued earlier, but those who are especially well qualified to discuss them should be asked in advance to prepare a discussion and if they cannot attend the convention to forward it to the secretary. This will bring out much important data and will also afford a good means of getting the younger members to take a more active part in the work of the associations.

* * * * * * *

The committees gave more attention than usual to presenting the reports in abstract, but there is still much room for improvement in this direction. The suggestion has been made that each committee submit for approval an abstract of its report, suitable for presentation before the convention, at the same time that the report is sent to the executive committee for final approval before printing.

* * * * * * *

Undoubtedly the three most important papers which were considered at the Master Mechanics' Association were the New York Central Lines apprentice system, described in a paper prepared by Messrs. Cross and Russell; the paper on "Shop Cost Systems," presented by Mr. Lovell, and the report of the committee on superheating. That the shortage of skilled labor and the difficulty of securing good foremen is getting to be a serious problem in the mechanical department of our railroads was evinced by the enthusiastic discussion of the apprenticeship question.

It is rather discouraging that there was not a more thorough discussion of Mr. Lovell's paper and it would seem that very few of those present had any idea of its value or broad significance. There can be no question but what the output of a shop depends much more on its organization than upon the equipment and that the only way to make any considerable general improvement in a shop is to bring up the efficiency of each individual in it. The possible returns from this source are many times greater than from anything which can be accomplished by improving the equipment. The Santa Fe has been very fortunate in having evolved a system by which the efficiency of each man in the organization can be accurately determined, either in the shops, or roundhouses, or the efficiency of the shop or roundhouse as a whole can be determined. Possibly this feature may have been considered too briefly in Mr. Lovell's paper and those of our readers who may wish to make a more complete study of it can easily do so by referring to the articles in our June paper on the "Methods of Exact Measurement Applied to Individual and Shop Efficiency at the Topeka Shops of the Santa Fe," by Mr. Harrington Emerson, and "Roundhouse Betterment Work," by Mr. J. F. Whiteford. This question of individual efficiency is not something that is tied up to the bonus system, but it can be worked out easily under other systems, as suggested by Mr. Vaughan in the discussion of the paper.

The report on superheating was a very careful study of the results which have been gained on this continent up to the present time. The discussion was rather disappointing in that so few took part, but this is not to be wondered at when we learn that at the end of 1906 there were only 19 locomotives in the States which were equipped with superheaters and that six of these were on the Rock Island System. The Canadian Pacific Railroad at that time had 176 superheater engines in service and has since received or has on order 176 additional ones. That the application of the superheater to locomotives has been successfully solved and that the credit for adapting it to the conditons met with on this continent is almost entirely due to the Canadian Pacific Railroad and Mr. Vaughan is beyond question. The roads in the States have been very slow in taking this matter up and possibly, as suggested by Mr. Vaughan, this was a wise move on their part, as they were relieved of all the trouble and expense to be met with in developing a feature of this kind for practical use and yet Mr. Vaughan frankly admitted that while the difficulties which were met with on the Canadian Pacific were very great, yet in spite of this the railroad was the gainer from a financial point of view. Now that the Canadian Pacific have paved the way it is to be hoped that the railroads in the States will take advantage of what has been accomplished.

MASTER MECHANICS' ASSOCIATION.

FORTIETH ANNUAL CONVENTION.

The convention was called to order on June 12th on the Steel Pier at Atlantic City by the president, Mr. J. F. Deems. Mr. Deems' address, part of which is reproduced on page 253, was of an entirely different order from that which is customary. No attempt was made to review in detail the work of the Association or to suggest means of solving the present motive power department problems. Mr. Deems confined himself to calling attention to the most important problem before us at this time, that of *men, the training and building up of men for the work of the future.* The address was short, forceful and to the point and was characteristic of the man who made it. It met with the hearty approval and indorsement of those present.

The secretary's report showed the present membership to be as follows: Active, 819; associate, 17; honorary, 4; total, 876. The treasurer's report showed a balance on hand of $2,739.11.

Mr. A. B. Marsh has completed his four years' course in the Joseph T. Ryerson & Sons scholarship at Purdue. This scholarship will be continued for another four years. There are three vacant Master Mechanic scholarships at Purdue University. Beginning with the next college year there will be four Master Mechanic scholarships vacant at Stevens Institute of Technology, Hoboken, N. J. Messrs. J. Snowden Bell and Lawford H. Fry were elected as associate members. Messrs. W. C. Ennis and Henry Elliott were elected to honorary membership.

MECHANICAL STOKERS.—The report was received and the committee was continued for another year. In discussing the report Mr. J. F. Walsh stated that he had found the mechanical stoker necessary and successful with the narrow and long fire-boxes on heavy locomotives in freight service, but that with wide fire-boxes on engines doing the same work it was not necessary.

SHRINKAGE ALLOWANCE OF TIRES AND DESIGN OF WHEEL CENTERS.—The report was accepted and the committee was instructed to prepare its recommendations for letter ballot. The lip on the outside of the tire was recommended because it made a much simpler machine job than when on the wheel center and on the inside. The sudden increase in shrinkage recommended for wheels above 66 in. in diameter is due to the greater elasticity and flexibility of the larger wheel centers.

LOCOMOTIVE LUBRICATION.—The consideration of this report precipitated a lively discussion, mainly as to the recommendations of the committee concerning the number of miles to be run per pint of oil. Several instances were cited of exceptionally good records which had been made, but the general opinion seemed to be that these were due to the expenditure of more time and trouble than could reasonably be expected of the engineer.

APPRENTICE SYSTEM ON THE NEW YORK CENTRAL LINES.—This was the most important paper presented at the convention. The complete paper and the more important parts of the discussion will be found on page 253 of this issue.

SHOP COST SYSTEMS.—The individual paper on this subject, prepared by Mr. A. Lovell, superintendent of motive power of the Santa Fe, was, in his absence, abstracted by Mr. Harrington Emerson. Next to the apprentice question this was the most important subject under consideration and it is unfortunate that there was not a more thorough and complete discussion. That part referring to the determination of the efficiency of the individual workman or of the shop as a whole is of vital importance, and sooner or later our railroad managements have got to come to the full realization of this if they expect to produce the best results. Part of the discussion is reproduced, in connection with the paper, on another page.

SUPERHEATING.—The report was abstracted by Mr. H. H. Vaughan. Mr. C. A. Seley said that his road had made some changes in the arrangement of the Cole superheater, which is now giving satisfactory results.

Mr. Vaughan said: "This question of superheating is developing rather peculiarly. We are in it very heavily. At the end of

this year we shall have about 375 engines equipped with superheaters, all big engines; and in the States, while there have been a few spasmodic instances, nothing at all has been done on any large scale. In my opinion the roads in the States have done very wisely. We have had a great deal of trouble in our experimental work with superheaters. We have made money, but we have had a lot of things to find out. I believe inside of another year we can definitely and reliably say that you can equip engines with superheaters, and if you will give them attention—not expense, but attention—you can run without any more trouble than you have with the ordinary simple engine. I would like to emphasize the difference between attention and expense. If a device is put on an engine and when an engine comes in and a damper packing is leaking, and a man goes to work and sticks a gasket in the joint, and the round-house foreman sees the damper is not working, and lets it go, and the flame is going through the tubes, and they deteriorate at the return bend, and then a return bend blows off and it is necessary to take down the headers and cut the engine out of service, and the transportation department says, as I heard one man say,—"We call them freezers, not superheaters,"—that all comes from lack of attention. It would not have cost five cents to have replaced the packing right in the first place. If we are going to give up a device that will save from 10 to 20 per cent. on coal just because we cannot get round-house machinists and foremen to pay attention to things, we are going on the wrong track. It is a question of attention with superheaters, and not of expense."

"We have the records from passenger service of the number of failures, and of these failures a large number came from the use of bronze nuts. There are only three failures that are serious in 198,000 miles. That shows definitely, I think, that you do not have enough engine failures with superheaters to condemn them. The road records show that they do make a satisfactory saving in coal. Therefore I think superheating is a thing that is worthy of careful attention and should be taken up properly. I would like to call one more point to your attention. We frequently hear it stated that our coal only costs us $1.50 or so and it is hardly worth our while to go to the superheating, almost always forgetting that coal that costs $1.50 originally may not cost $1.50 where it is burned. It costs money to haul coal to the place where it is burned. There are many roads showing coal at $1.50 on the performance sheets, that are hauling it 300 and 400 miles before it is used. You cannot haul it much under one-half a cent per ton per mile and that runs up very quickly, and there are very few roads that cannot afford to spend $800 or $1,000 on a new engine."

"Since going to superheating we have reduced the pressure on all our new engines built, to 180 lbs., increasing the size of cylinders in proportion, and so far as we can see, with equally satisfactory results. We are going to derive the benefit from decreased boiler troubles, and get the same economy, and just as lively an engine."

In reply to a question from Mr. A. W. Gibbs as to the size of piston valves and forced lubrication, Mr. Vaughan said: "We use a 11-inch piston valve for a 21-inch cylinder, and we have since enlarged that cylinder to 22½, and still use the 11-inch valve, with results entirely satisfactory. I have had a feeling though that we have gone about as far as is necessary in putting an 11-inch valve on a 22½-inch cylinder. Of course that is a considerably smaller valve than you would use in general practice with saturated steam. Forced lubrication I do not believe to be necessary. I think the sight feed lubricator works better on a superheated engine than on a saturated engine."

Cause of Leaky Flues.—Mr. M. E. Wells in opening the discussion of his paper called attention to a letter from Mr. W. H. Lewis, stating that nearly one-half the engines came in dry but leaked after they were placed over the cinder pit because of filling them up with cold water.

Mr. E. P. Roesch (Southern) stated that flue leakage increased in the same ratio as the number of times the fires are knocked or the boilers washed. He mentioned several tests which he had made, one of these being as follows: "We took an ordinary wide firebox locomotive with 385 flues and put it over the cinder pit and knocked the fire. Preliminary to this test we opened up the front end and cleaned off one flue and arranged a long piece of wood, with a micrometer attachment in the rear end of it. After the fire was knocked it still had 135 pounds pressure, or 358 degrees of heat. The length of the flue was taken, and at the same time this length was scribed on the side of the boiler. After the engine stood quiet for three hours and fifty minutes without any water being injected into the boiler, the pressure had dropped to six pounds, or 230 degrees temboiler had contracted just an even sixteenth inch in the length, corresponding to the length of the flue, and the flue had contracted 3/32 inch, showing that the flue, through the action of the air through it, had contracted more than the boiler itself. After the engine stood two hours and thirty minutes longer the pressure had dropped to six pounds, or 230 degrees temperature. We found then that the boiler had contracted 14/64 inch while the flue had contracted but 9/64 inch, showing that owing to the difference in the amount of metal in the boiler and flues, the final contraction of the boiler was greater than that of the flues, and produced a pushing and pulling action.

Proper Spacing of Flues in High Pressure Boilers.—The report was read by Mr. C. E. Fuller, following which Mr. Tonge presented a supplementary report including an account of the saving which had been effected on one road by a redesign of the flue spacing in its locomotives.

Mr. Wells said that he believed there was no question but what wider spacing of the flues was an advantage, particularly with poor water.

Mr. Gaines drew attention to the fact that by the use of a smaller back end on the flues, all the advantages of the wider spacing were obtained. He also mentioned that a too generous use of the rollers was responsible for much flue leakage. Mr. West stated that his road was following the methods recommended by Mr. Gaines with much success.

Mr. W. Forsyth stated that the facts brought out in this report had been known for several years, and it was peculiar that the builders still used the narrow spacing. He suggested that careful tests should be made on the matter of flue spacing and the evaporation from flues of varying lengths.

Mr. F. H. Clark reported that his experience had been that wider spacing did not always result in improvement, and that other affecting conditions should be considered.

Mr. Vaughan stated that flue spacing was largely a matter of conditions. Engines with narrow bridges run satisfactorily in good water districts, but bad water districts required wider bridges. He believed that a mistake was made by heavy prossering of flues in bad water districts, as this gave an excellent opportunity for the accumulation of scale and neutralized the benefit of the wider bridges. He advised doing away with prossering altogether in bad water sections. He did not agree with the idea of using fewer flues to save the cost of safe-ending them; the boiler should have all the flues possible so long as the circulation is not interfered with. Mr. Vaughan also opposed the idea of going to the expense of making careful tests on this subject, as he did not believe that such tests could be made with sufficient accuracy to give results of value. He instanced the St. Louis tests as an example.

Mr. Wagstaff agreed with Mr. Vaughan in that each different set of conditions required different treatment. He said that flues were like other things, in that good care would give equally good results.

Mr. W. Forsyth moved that a committee be appointed to ascertain the most economical spacing of flues in locomotive boilers, and the relative value of the heating surface of flues of different lengths.

This motion was opposed by Mr. Vaughan for reasons as stated above; also by Mr. McIntosh on the same grounds. The motion when put to a vote was lost. The committee was continued another year.

Results of use of Different Valve Gears.—The report of the committee was read by Mr. Seley.

Mr. Gaines brought up a point in favor of the Walschaert gear, in that on his road it had become necessary to relieve the engineers of responsibility for inspection at points where there

were no inspection pits, because of the impossibility of their getting underneath the engines.

Mr. E. A. Miller stated that during four months he had had 12 failures of valve gear on 15 engines equipped with the Stephenson motion and only 1 failure on 10 engines with the Walschaert gear.

Messrs. Manning and McIntosh reported entire success with the Walschaert valve gear engines on their roads. These cover practically all types with both piston and slide valves.

BLANKS FOR REPORTING WORK ON ENGINES UNDERGOING REPAIRS.—The report of the committee was read by Mr. Pratt.

Mr. Gaines stated that no form was provided for showing daily how many engines were ready for service, and how many in shop and for what class of repairs. He considered that such a blank should be provided.

Mr. Harrington Emerson spoke, in part, as follows: "In looking over the repairs of a large railroad company, we find that certain divisions will suddenly go all to pieces, they would apparently be in first-class condition, and inside of thirty days there was no motive power available, all the engines in the shop virtually. That was the kind of thing we ran up against on our road, so a method was devised that took the matter very largely out of the hands of the operating officials as far as information was concerned. Every single engine was put on an efficiency basis, in the same way that the men were put on an efficiency basis. The average of all the engines on the division had to average 100. If they did not average 100, it was evident that the engines were dropping backward, and we would find ourselves in a hole. If on the other hand the engines averaged more than 100 on the monthly average we knew the conditions as to that division were satisfactory. In connection with that the tonnage by months for a series of years was plotted in connection with each particular division, so that it was possible to say, without asking anybody whatever, in a general way, exactly the period of the year when all the engines on any particular division would be required for very heavy service, and also the particular time of the year when it would be convenient to shop more engines from a particular division than at some other period.

"Working along these lines it has been possible to plot the efficiency of the engines at any moment whatever, the efficiency of all the engines on the division, and plan months ahead as to just exactly how many engines should go into the shop and to tell the master mechanic three or four months ahead—you must put so many engines into the shop next August, because if you do not put them in in August you will be in trouble in September or October, and that has introduced an entirely different method from the one with which I was formerly acquainted, for shopping and looking after engines. I believe a paper on that subject by the men who now have charge of the system would be an exceedingly interesting one for this association at some future time."

Mr. Gaines moved that the committee be continued and instructed to investigate what is being done along the lines mentioned by Mr. Emerson. This motion was carried.

DEVELOPMENT OF MOTOR CARS FOR LIGHT PASSENGER SERVICE.—The report of the committee on this subject was read by the chairman, Mr. Ball. The report was supplemented by a brief description of the Kobusch-Wagenhals steam car being built by the St. Louis Car Co. It was announced that the report would be accompanied by a number of illustrations when it appeared in the proceedings.

There was no discussion.

PROPER WIDTH OF TRACK ON CURVES TO SECURE BEST RESULTS WITH ENGINES OF DIFFERENT LENGTHS OF RIGID WHEEL BASE.—The chairman of this committee stated that it was not ready to report and asked that it be continued.

A BLANK FORM TO GIVE A HISTORY OF LOCOMOTIVE MOVEMENT AT TERMINALS.—The report of the committee on this subject was presented in abstract by Mr. Basford. He explained that the blanks and methods advocated should not in any manner be considered as a means by which one department could throw the blame on another. They are intended to assist in reducing delays by the co-operation and mutual assistance of the departments. He also explained that the blanks were not intended for continuous use, but only during periods of congestion when it is necessary to closely follow every locomotive.

Mr. Clark stated that he had a similar set of blanks in use and found them of much value during congestion.

Mr. Parish said that he had found such blanks of so much value during rush times that he believed it would pay to use them all the time.

Mr. Vaughan did not agree with the committee that the blanks should show under the head of "mechanical delay" only unnecessary delay, but thought this column should include all the time the engine was in the round-house.

Mr. Miller explained a blank which he was using with satisfactory results. This gave in some detail the time of the locomotive from the time it arrived in the yard until it was ordered out and left the yard.

Mr. Manchester explained that a similar blank on his road had resulted not only in improving the terminal movement to some extent, but also in showing up the physical shortcomings of some terminals so clearly as to make it easy to get appropriations to improve matters.

Other members reported the use of similar blanks with much success. There was some discussion of Mr. Vaughan's point of placing all the time at the terminal under the head of "mechanical delay," but no conclusion was reached.

LOCOMOTIVE FAILURES, RECORDS AND RESULTS OF KEEPING THEM.—The paper on this subject by Mr. W. E. Dunham was read by Mr. Pratt.

Mr. Gaines suggested that it might be advisable to appoint a committee to confer with the American Railway Association to determine a correct standard for an engine failure.

Mr. Manchester considered there were many good suggestions in the report, but criticized some of the blanks suggested therein as being too slow of action.

Mr. E. A. Miller stated that on his road a blank had been in use about two years, on which the engineer reported directly to the superintendent of motive power. From this a monthly statement of engine failures showing 87 items was worked up. By this means failures had been reduced 50 per cent. This scheme also included a record of man failures.

Mr. Roope stated that if something was done to avoid engine failures there would not be a need for so many blanks to keep track of them.

SUBJECTS.—The report of this committee was referred to the executive committee.

OFFICERS.—The election of officers for the coming year resulted as follows:

President—William McIntosh, S. M. P. Central R. R. of New Jersey.

First Vice-President—H. H. Vaughan, assistant to vice-president, Canadian Pacific Ry.

Second Vice-President—G. W. Wilden, assistant S. M. P., Lehigh Valley R. R.

Third Vice-President—F. H. Clark, G. S. M. P., Chicago, Burlington & Quincy Ry.

Executive Committee—C. A. Seley (C. R. I. & P.), F. M. Whyte (N. Y. C.), John Howard (N. Y. C.), A. E. Mitchell (N. Y. N. H. & H.)

TOPICAL DISCUSSIONS.

IS IT DESIRABLE TO ELIMINATE WATER GAUGE GLASSES ON LOCOMOTIVES TO ENFORCE THE USE OF GAUGE COCKS?—This subject was opened by Mr. F. F. Gaines, who stated that in his opinion it was desirable. However, there are some features to be considered which might prevent such action. One of these was the legal aspect, as it was understood by the speaker that several States had laws requiring the use of the water glasses. It developed later that New York State had such a law. Mr. Gaines had found that about one-half the engineers on his road preferred the gauge cocks, while the others preferred the glass, and he had not as yet taken any action as to the removal of the glasses.

Mr. E. A. Miller believed that the education of the men had

much to do with the question, as those who were in the habit of using the glasses objected strongly to their removal. A water glass should not show a higher water level than the top gauge cock. He instanced a case where an additional three inches on the glass had resulted in an epidemic of broken pistons due to carrying too high a water level.

Mr. McIntosh stated that this subject had been up for discussion for many years, and read from the proceeding of 1893 a resolution to the effect that water glasses were not necessary.

Relative Merits of Outside and Inside Delivery Pipes in Connection with Locomotive Injectors.—The discussion was opened by Mr. Strickland L. Kneass, who spoke at some length in favor of the inside delivery pipe with the check valve on the back head. The more important reasons advanced were: greater safety to passengers and employees, more convenient location of injectors, no loosening of check valves by creeping of branch pipe, more even distribution of feed water over the flues, and saving in cost of long copper pipe with its bends and fitting.

Corrugated Tubes for Locomotive Service.—This subject was opened by Mr. G. W. West, who said that the corrugated tubes had given excellent service on his road. They made double the mileage of the plain tubes, did not fill up nearly as badly and gave much less trouble with leakage. The locomotive fitted with them threw practically no sparks, and did not burn the paint off the front end as quickly as other locomotives in the same service.

Mr. Roesch stated that his road had a set of corrugated tubes in service, but they had been in use too short a time to give any definite results.

What is the Best Material for Hub Liners for Driving and Engine Truck Wheels, the Best Method of Applying and the Limiting Lateral Play for Such Wheels Before Repairs Are Required?—The secretary read a letter from Mr. J. F. Dunn opening the discussion. This stated that babbit was considered the best metal and should be poured into a recess in the face of the box with dove-tailed depressions on the bottom to hold it in place; 5/8 in. should be the maximum lateral wear in driving boxes and 3/4 in. in truck boxes.

Mr. McIntosh reported success with babbit hub liners, especially with steel wheels.

Mr. Pratt asked information as to what effect different lubricants had on the best material for this purpose, stating that he had had difficulty with friction at this point when using grease in driving boxes.

Mr. Walsh stated that he had abandoned babbit and gone to bronze for hub liners, because of the low melting point of the former and the impossibility of keeping it in place when using grease.

Mr. Roesch reported the same trouble.

Mr. Minshull and Mr. Roope reported good success with babbit, the latter drawing attention to the fact that babbit should in all cases be sweated on the box.

Other members reported success and failure with both babbit and bronze, and the subject seemed to hinge on the service the locomotive was in, kind of lubrication and method of applying the liners.

Mr. Franey described the method of pouring the crown brass and liner at one operation, which is in use on his road, and is described in detail in an illustrated article elsewhere in this issue.

The subject was finally disposed of by a recommendation that a committee be appointed to report next year.

Abstracts of Reports and Individual Papers.

Shop Cost Systems and the Effect of Shop Schedules Upon Output and Cost of Locomotive Repairs.

Individual Paper by A. Lovell, Supt. M. P., A. T. & S. F. Ry.

The problem of determining shop costs is a very intricate one, and one that railroads in general have not gone into in detail. Keeping trains moving and handling the business presented has so fully occupied the time of railroad officials that the problem of determining cost accurately has been left for a future date.

The general principles have been: Get the engines through the shop, keep the pay-roll down, and do the business. Increased capacity has been more important than superior economy. Some roads undoubtedly are better than others in some things, but a comparison of cost sheets will show such decided differences in cost that the only conclusion to be drawn is that different methods are employed in determining costs.

As far as shop costs are concerned, differences as to engine repair costs may arise from doing a large part of the labor of finishing material on shop or store orders. When an engine comes into the shop, this finished material is drawn from the store department and applied to the engine. The value of this will then all appear as material, and the labor cost of the engine getting the finished material will be reduced a corresponding amount. As an example, the total cost of engines, including labor and material, through two large shops of different systems for the same month was as follows:

	Labor.	Material.	Total.
Road "A"	$21,667.10	$22,323.64	$43,990.74
Road "B"	28,259.64	15,180.49	43,440.13

The total output of engines was practically the same in each shop and the total difference in cost of engines was only $540.00 on the month's output, yet on one road the labor charge was $6,592.00 less than on the other. This is probably a case where there was a difference in the method of determining costs.

SURCHARGES.

The surcharge or amount to add to the direct labor charge is another item of variance. Every road distributes direct labor or pay-roll to engines and shop orders. This is easy. Almost all roads add something to this to cover expense of handling. Some roads are looking into the question of going still further and adding to the cost of the shop output all the items of cost that make up the total expense of running the shop. This is an intricate problem, and, while all agree that items such as rent, supervision, machinery, power, heat, light, water, etc., enter into the cost of the shop output, few are attempting to distribute these items.

Railroads determine costs principally for the purpose of making comparisons between different shops on their lines and also to compare costs in the same shop from year to year. A commercial concern must distribute all its costs to the value of the output so as to determine the selling price. Railroad shop accounting from the mechanical standpoint is different. The railroad is only after a comparative figure to compare one year with another or one shop with another. If the cost of running the power plant is kept as a separate item, we can follow this from year to year and bring pressure to bear to improve it when possible. There is no reason why this item should enter into the cost of repairing engines unless it is desired to compare the cost of what is being done in the railway shop with the price for which some outside concern is willing to do the same work.

It would be well if the cost of the output was determined accurately and scientifically; but as the railroad shops can continue to run efficiently without taking up this special matter, and as no two experts agree as to the best method of actually making the distribution of the surcharge, it is not likely that the matter will be taken up very seriously for some time to come. It is an accounting matter and does not affect relative costs of repairs at different periods and shops on any one road.

Repair shops having been built, the machinery installed and the power plants running, the expense of maintenance will continue as a constant charge; and it is immaterial, as far as comparative costs are concerned, whether they are divided into small quantities and distributed, or allowed to remain in one lump sum. The objects of making a complete distribution of all surcharges, then, is to determine the advisability of buying certain few articles on which manufacturers may desire to compete, and also to determine the economy of purchasing new machinery, making shop extensions, etc.

In its present stage this is a matter for the accounting department to thrash out. When accountants are more united as to how all overcharges should be handled, it will then be proper to take the matter into more earnest consideration. For the present, officers of the mechanical department are principally concerned in keeping the pay-roll down and increasing the number of engines turned out of the shops, resulting in a reduction in repair cost per ton mile of traffic handled.

STANDARD UNITS OF SHOP OUTPUT.

Another point in the matter of accounting that all are trying to solve is a fair unit of shop output on which to base costs. The number of engines turned out, which is the unit commonly used, is misleading and crude, as some engines require more work than others, some are heavier than others; no two, in fact, require exactly the same units of work to be performed on them. A solution of this is to determine total output of the shop in standard units, a standard unit being the amount of work that a standard workman performs in one hour. This determination of standard units performed necessitates complete schedules of every job, but instead of having the schedule show price per job, these schedules show standard units or hours per job.

To determine the total standard units or hours of output the schedule or standard times on every operation performed must

be added together. Having determined the standard units of output, we can also determine the efficiency of the shop, as the ratio of actual hours worked to standard units or hours turned out is the efficiency of the shop. This gives a perfect basis for comparing one shop with another, one gang with another or one individual with another. The diagrams shown represent graphically standard units or hours and actual hours worked, Fig. 1 for a complete shop by months, Figs. 2, 3, 4 for individual workmen by days.

ENGINE SCHEDULES.

Scheduling of engines through shops will have a decided influence to keep everything moving and save delays due to one department waiting on another. Engine schedules must be made very carefully. It is as much of a task to make out the schedules for a shop as it is to make out the time card for a division. The schedules that work satisfactorily in one shop will no more apply to another than time cards can be exchanged. Care must be used or some one gang or machine will be crowded with more work to be done at one time than it is possible to accomplish. This brings about a condition somewhat analogous to that on a single-track road when an effort is made to put too many trains on the same siding at once. It cannot be done, and, instead of keeping up to the schedule, everything will be delayed until the necessary switching and see-sawing has been accomplished and the track is cleared.

Engine schedules bear the same relation to getting work through the shop that time cards do to getting trains over the line. Every possible effort is made to live up to schedule, but when everything goes wrong, the dispatcher, in the case of trains, and the general foreman, in the case of the shop, must take a hand, devise new meeting points, hold some trains back, advance others—in fact, run everything special until business is straightened out once more. It is no more possible to keep every engine in a big shop moving on schedule time than it is to keep every train between Chicago and New York on time. If it is found that engines are continually behind schedule, it may be due to two causes: First, the schedules are so fast that it is impossible to live up to them; second, something is wrong in the shop and needs bolstering up. The experience of those who have scheduled engines through a shop is that schedules are of little use unless some real and earnest effort is made to live up to them.

The work on engines is never twice exactly alike; also the men in the shop are continually changing. Both of these conditions tend to prevent an even movement of engines through the shop. The best solution of this matter of varying amount of work on the engine and of varying numbers of men to do the work is to have a floating gang composed of all-around mechanics to act as a balance wheel for the whole shop. This gang should be used to jump in and bring any engine that is behind schedule up to date.

In some shops it has been found well to have this extra gang work at night; in others it works during the day. In either case it should have a light repair, unscheduled engine of its own to work on, in case it is not needed to bring some laggard up to the mark. It is only by having a floating gang to act as a balance wheel, that the work can be kept moving smoothly through the shop. One road using this system has three classes of schedules and every engine entering the shop is placed on one of these schedules.

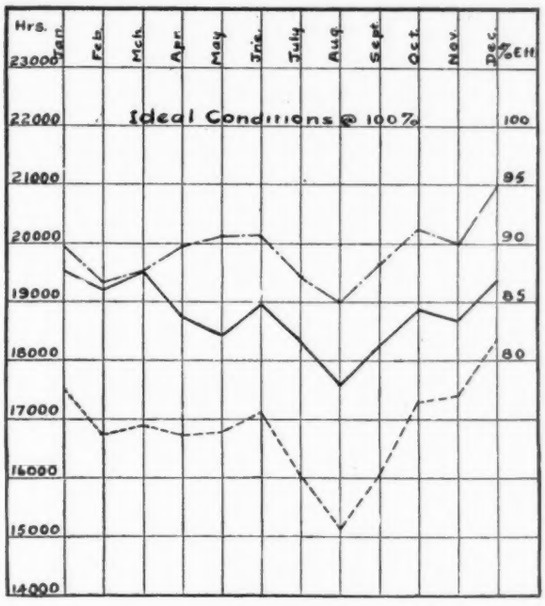


FIG. 1.

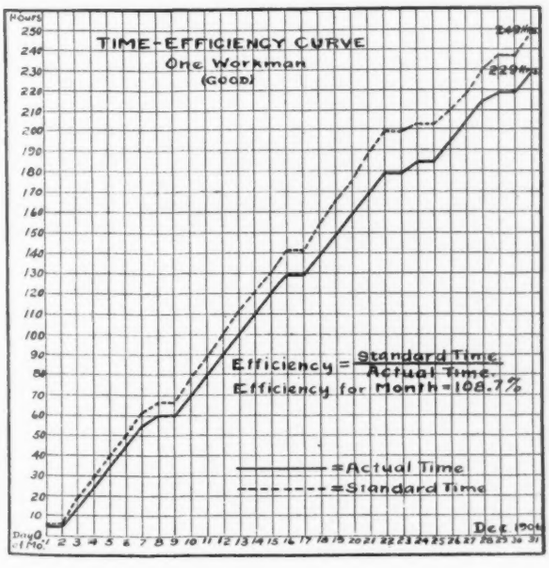


FIG. 2.

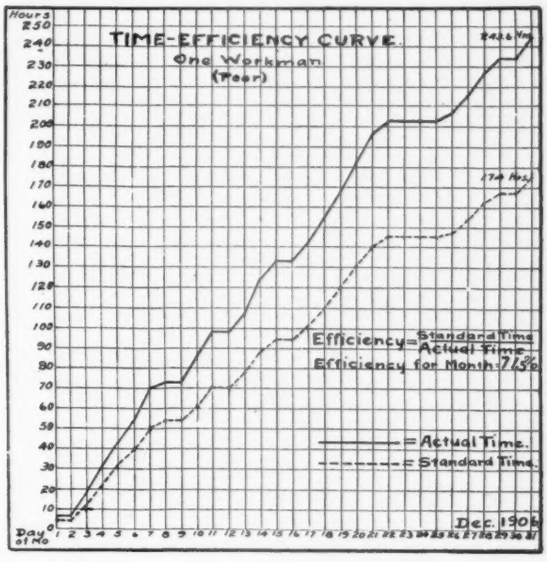


FIG. 3.

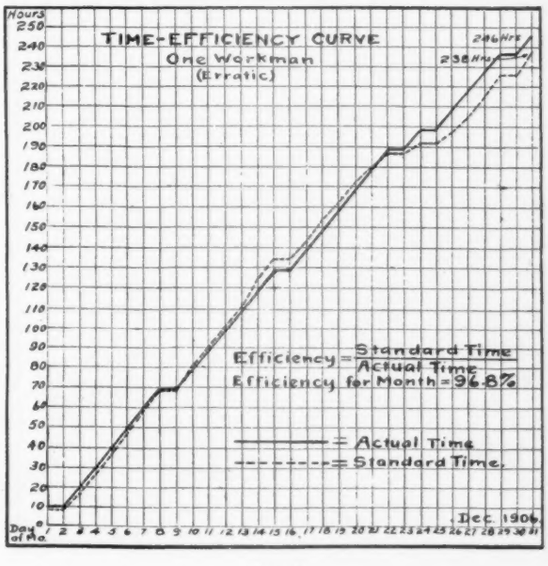


FIG. 4.

Schedule No. 1 for light repairs: Light repairs consist of minor repairs, the cost of which, including labor and material, is more than $50 and less than $500.

Schedule No. 2 for heavy repairs: Heavy repairs consist of thorough overhauling of machinery and such boiler work as can be done without placing the engine in the boiler shop. Cost of heavy repairs, including labor and material, more than $500 and less than $1,200.

Schedule No. 3 for general repairs: General repairs consist of thorough overhauling of machinery and applying a new firebox, or other such heavy boiler repairs as may require the engine to be placed in the boiler shop. Cost of general repairs, including labor and material, to exceed $1,200.

Even with these three classes of schedules there are some adjustments required for special cases. Many times it is the train problem over again and our train has on a few extra cars. All that can be done in such cases is to do all possible to keep up to schedule, and when there is a general falling down, leave matters to the train dispatcher or shop foreman to get the train or engine through the best way possible.*

The shop using these schedules is operated by the gang method and each foreman has a card showing when his particular work is to be done. At 7 o'clock each morning a written notice is handed to each foreman showing how his work stands and a summary is given to the general foreman showing how all the work stands. The general foreman is also given a report showing how many and what class of workmen each gang is short. By comparing the work report with the labor report he is able to assign men from the floating gang to gangs that are liable to fall behind. This method passes engines through the shop with the regularity of mail train service and, combined with a system of rigid inspection and assignment of work, gives the minimum delay with the minimum cost for repairs.

Scheduling of engines:

1. Saves confusion and bunching of work.
2. Aids the general foreman to exercise a much better supervision over gangs that are in trouble.
3. Prevents waste of energy by one gang doing work at a time, or in a way, that will interfere with other gangs.
4. Permits the placing of responsibility immediately and correctly on the gang or gangs responsible for an engine delay.

Scheduling in itself will not reduce costs except to the extent that false moves are cut out, and, in general, increased shop output or efficiency means reduced cost. Scheduling does, however, reduce costs when supplemented by the following system of keeping account of labor charges.

Each engine coming into the shop is thoroughly inspected to determine what repairs ought to be made. The inspector's report is made out, showing in detail just what each gang is to do. In addition, the cost of this work is estimated in detail for each gang.

The work to be done by each gang is written up and handed to the foreman. The following is a copy of the work slip given to the foreman of the guide and piston gang for Engine 429 passing through the shop for general repairs in February:

WORK TO BE DONE ENGINE 429, GENERAL REPAIR.

Guide and Piston Gang No. 21.

"Order new right piston complete; right front cylinder head and both right cylinder casings; material now on shop order. Bore both cylinders; just clean them up. Order new left piston complete; crosshead keys; new nuts on crosshead pins; new side liner on crosshead; all new cylinder packing. New piston rod packing and vibrating cups. Hang the guides; put in pistons and see that they have proper cylinder clearance. Put up heads and casings. Put oil cups on guides."

All the gangs in the shop are numbered. See AMERICAN ENGINEER, September 1906, page 338.)

The timekeeper charges all of the floor time to both engine and gang numbers. When the engine leaves the shop the cost of each separate gang is figured as soon as possible and a report † furnished the shop superintendent, showing the total gang charges to each engine, together with estimated charges. This furnishes him with just the data needed in order to determine which gangs are spending money economically and which are wasteful. He has the estimate of what each gang should have cost and the record of what the gang did actually cost. When there is a discrepancy, the foreman is called to account.

The gangs are held down very rigidly and not allowed to do any work not called for on their work slip. If a gang foreman finds, after the engine is in the shop, some work to be done not called for by his work slip, he must report this to the inspector, who will allow and authorize an extra expenditure to cover the extra work, if he deems it necessary. It is by this close watch that a large saving in labor can be effected, as it prevents unnecessary work being done and makes the inspector responsible for everything done to the engine. Foremen who are inclined to build an engine like a watch are restrained, while those who are inclined to slight their work are spruced up.

The scheduling and keeping track of costs as described above means increased output, because the individual worker is being watched more closely. He is not forced to work any harder than without it, but is prevented from making false moves, getting in the way of other workers, and from doing unnecessary work. The total output of the shop is the sum of the output of each individual worker. This should constantly be borne in mind and no system adopted that will not help each individual worker, as he is the man on whom the output depends.

* EDITOR'S NOTE:—At this point a complete outline of the three schedules is given. These cover practically every detail job to be done on an engine.

† For copy of one of these reports see AMERICAN ENGINEER, December, 1906, page 473.

Abstract of the Discussion of Mr. Lovell's Paper.

Mr. Harrington Emerson.—In the absence of Mr. Lovell, I have been asked to abstract this paper. The reason is, probably, that for three years I was intimately associated with him in this work in his department. It is a welcomed opportunity to express publicly the great obligations I am personally under to him for what was finally accomplished. Some men are of assistance by helping one to build up and do right; others are of not less valuable assistance in preventing one from going wrong. Mr. Lovell has one of the keenest minds I ever met in detecting the weak spots, the faulty links in any plan, and time and time again, his criticisms made it necessary to pause, to start over again, to amend and to correct. Mr. Lovell was from Missouri, he had to be shown, but when at last he was convinced, there was no one more willing to support, to defend if need be, than himself. This paper of his outlines some fundamental principles on which we finally agreed, and rejects others that he is not yet prepared to accept. Without disloyalty to him I may in the discussion be permitted to come to the defense of what he is still unwilling to accept.

You will notice from the diagram that the efficiency of the shop has theoretically been increasing from August to December, it being 85 per cent. in August and 95 per cent. in December. This is an ideal diagram, not based on actual facts. Now, any system whatever that will produce that kind of result is a good one, and it is not necessary that it should be any particular kind of system, but it is essential if the efficiency of a shop is to be improved that there shall be some method of showing the relation between what actually is and what should be, and that is defined as shop efficiency.

I now take up those matters in which I dissent somewhat from this report. "In its present stage this is a matter for the accounting department to thrash out. When accountants are more united as to how all overcharges should be handled, it will then be proper to take the matter into more earnest consideration. For the present, officers of the mechanical department are principally concerned in keeping the pay-roll down and increasing the number of engines turned out of the shops, resulting in a reduction in repair cost per ton mile of traffic handled."

The trouble in a great many shops is that neither the foreman nor anybody else knows the cost of the operation, doesn't know whether it is more economical to employ a cheap man that takes a long time, or to employ a high-priced man, who takes a short time; doesn't know whether it is more economical to do work on a cheap machine that takes a little longer or to do it on a very expensive machine that takes a shorter time, and the consequence is that in a great many shops recommendations are made in the hope of accomplishing economy that have exactly the opposite result, that after these so-called improvements have been put in, the costs instead of going down are found to have risen very materially.

It seems to me that to turn the matter of shop administration over to accountants is a very serious and grave mistake. The accountant has a very important duty to perform. He has been trained to account for where the money goes to but "efficiency" is not any part of his duty. The superintendent of the shop should aim at efficiency, and it is no part of his duties to follow up particularly how the money comes in or how it is spent, provided he realizes a high shop efficiency. I could well imagine on a rifle range that the man keeping the score would keep the same kind of a score whether the rifle carried a hundred yards or a thousand yards. The score in each case would be similar. But there is a tremendous difference in the value of the two rifles, whether they shoot straight at a hundred yards or at a thousand yards.

The method of determining costs is important. The cost consists of material, of labor, of machinery and of a departmental charge. Now, unless you know as to every single item that is worked upon or done, the cost of the material in it, the cost of the direct labor, the cost of operating the machine that is used on it and the general costs of the department, it is impossible to tell whether one method is better than another; whether you shall charge a little more for interest or depreciation or a little less is unessential, but unless you have a correct method of determining the actual cost of each unit of work it will be absolutely impossible in any shop whatever to bring costs down to the lowest possible point.

Mr. H. H. Vaughan (C. P. R.)—It appears to me that Mr. Lovell has described a system of shop costs—I do not know whether it is new to all the members, but it certainly is very new to me—which is one of the neatest and most complete arrangements that has ever been brought out, to my knowledge, in the direction of keeping track of men's efficiency. He has supplied

the key to make one of these operation cost-systems practical and useful by taking the standard time or cost on each job, and compiling the figures for each man each month, and then for all the men each month, and thus we have a system which appears to me probably equal to any piece-work system we could devise. In a good many of our smaller shops piece-work systems are difficult. The work comes along in such a way that it does not allow of piece-work systems being satisfactorily introduced, and those shops are being judged very largely on their output of general repairs, or output of intermediate repairs.

We have never had a system for keeping track of each man's efficiency, or each gang's efficiency, in the way that this system does. I think this is one of the most remarkable papers that we have ever had in that sense. It shows us a way of inherently and systematically following a man's output and a shop's output in a way in which we have never been able to do it before by building up from each unit a completed work. It is worthy of very careful study, and for my part, I do not see why a road that is working some shops piece-work and other shops day-work, could not use this system to put their piece-work prices right into the day-work shops and have some measure of these smaller shops.

With regard to the surcharge question, I can see what Mr. Emerson means about the value of really getting into the surcharge. It seems, however, that railroads are being run to a certain extent different from manufacturing concerns. Our accounts are dominated by the general accounts of the road; the distribution of these accounts is pretty well determined by the Interstate Commerce Commission, and we have certain accounts, such as superintendence, fuel and light for shops, repairs to tools and machinery, etc., which are separate from the repairs to locomotive accounts by general agreement. Now, where these accounts can be best distributed in proportion to the labor, there is, I think, no object whatever in railroad accounting in adding that on to the cost of the work.

The thing that Mr. Emerson brought out, which I agree with him is of importance, is a record of the investment and cost of operating tools. I think very frequently when we get expensive bar lathes in a shop, our foremen are very apt to put work on an expensive machine and be proud to do it in 25 minutes, instead of an hour and a half in a lathe, when the cost of that machine altogether eats up the saving in the cost of labor. To that extent I agree with Mr. Emerson. I do not believe, with most of us, it is of much value in prorating on to the work those items that can only be carried as a percentage of the labor. It is easier to determine what they come to in a month, and if you are in competition with building establishments, as we are, and desire to know whether we produce our work more cheaply, we can take these percentages and add them to our cost, and determine whether it pays to make material or not.

Results of Use of Different Valve Gears on Locomotives.

Committee—C. A. Seley, chairman; R. Quayle, L. H. Turner, J. H. Manning.

As this Association was favored at its last convention with an admirable mathematical analysis of various forms of valve gear in use on locomotives, it is evident, from the wording of the subject assigned to this committee, that it is desired to present the practical considerations governing present-day locomotive engineering in regard to choice and design of valve gears and the results obtained in general practice and use. The subject is, perhaps, the least understood of all the detail mechanism of the locomotive, and while most railroad and drawing offices can produce men competent to lay out and design the ordinary type of motion, yet the builders are very generally called upon to furnish the design, subject possibly to a specification that allows and expects the builder to use his best judgment in regard to these important details. That this confidence is not misplaced is to be seen daily in the fine performance of engines the country over, in all classes of service, fast and slow, passenger, freight, work and switching.

The Stephenson link motion has held its own in this country, almost without consideration being given to other types, until within very recent years. The types and weights of engines employed lent themselves to convenient use of this type of link motion which has many desirable and valuable features to commend it.

The time came, however, when it became expedient to make changes for some of the following reasons: Some types of engines have so many wheels or they are so closely grouped that it is a difficult matter for enginemen to get under them except when over a pit. This contributes to neglect, lack of prompt adjustments for wear, lack of proper inspection and a more rapid deterioration. With the increase in size and weight, the dimensions of eccentrics required for large axles are excessive and their peripheral speed is so great as to make maintenance and lubrication of the eccentrics and straps expensive and troublesome.

By the abolition of eccentrics and straps, a long list of engine failures is eliminated; expense for maintenance and lubrication reduced; room gained for better cross-bracing and strengthening of frames and adding to convenience on account of the men not being required to go under the engines to the same extent. On heavy engines, the weight of all moving parts of a link motion, from the eccentric straps through to the valves, is so great as to contribute to accident and rapid wear so that an equally efficient valve motion with lighter parts and greater accessibility is in demand for heavy power.

For many reasons, we cannot lower the standard of efficiency as set by the Stephenson link motion. Economy in use of coal and water are more necessary than a reduction in weight and wear of valve motion parts. No railway manager will sanction the use of a device, no matter how beautifully simple it may be, if his costs as measured in coal are increased thereby. Fortunately, we are able to obtain a valve motion having the desirable features of lighter parts and accessibility without a loss of efficiency in the Walschaert motion, which has come into extensive use the last few years.

At this point in the report valve motion diagrams were introduced, made by a special machine devised by the Baldwin Locomotive Works. These clearly showed that, notwithstanding the constant lead of the Walschaert motion, the pre-admission is more favorable at short cut-offs than with the Stephenson motion. This data also showed that the various points of pre-admission, port openings, equalization of cut-offs, release and the closures can be as favorably arranged with Walschaert motion as with the link motion examples presented.

The following tables of weights are given us for a 22-inch consolidation engine, said to be identical in everything except the valve motion, built by the Baldwin Locomotive Works:

	Complete Moving and Structural Parts.		Moving Parts Only.	
	Stephenson.	Walschaert.	Stephenson.	Walschaert.
Crossheads	676	746	676	746
Guide bearer	814	1,116	....	....
Guides	1,712	1,712	....	....
Eccentrics	600	....	600	....
Crank arms	....	250	....	250
Eccentric straps	1,100	....	1,100	....
Main crank pins	520	516	520	516
Links	238	413	238	413
Reverse shaft	325	655	325	655
Rockers and boxes	618	730	618	730
Rocker rods and hangers	169	....	169	....
Link bearing	....	234	....	....
Eccentric rods	184	264	184	264
Valve rods	220	546	220	546
Valve yokes	154	140	154	140
Valve rod guide	24	28	....	....
Complete set	7,354	8,321	4,804	4,265

These figures indicate that while the valve gear on the engine with the Walschaert motion weighed 1,000 pounds more, yet the weight of the moving parts was less. The AMERICAN ENGINEER AND RAILROAD JOURNAL of June, 1905, published some figures showing saving of weight by the use of Walschaert motion on L. S. & M. S. engines, as follows: 1,283 pounds on a consolidation, 1,215 pounds and 1,745 pounds respectively on two classes of Prairie type engines. These figures indicate a larger saving than the foregoing example, but it is possible that as these were early developments, they may not be representative of present successful practice. It is a fact that similar valve motion parts on engines abroad are very much lighter than we dare use in our own practice. It seems fair to conclude, therefore, that we may yet look for improvement in this respect.

The matter of lead has received much attention, particularly with link motion, but, as a matter of fact, the measured full gear lead is only used possibly for a few turns of the wheels in starting the engine, and when running notches are in use the lead is entirely different, the amount being dependent upon various conditions. As the running notch leads for best results are within narrow limits, it is apparent that the full gear leads vary within a wide range. The amount of full gear lead is therefore of little importance in the operation of the engine if the running notch lead is right. If these premises are correct, then there can be no argument as against the constant lead characteristics of the Walschaert motion, provided the lead is the proper amount for the running notches. The valve motion diagrams show that all the other events as derived by a link motion can be duplicated by the Walschaert motion so that, except in so far as the lead is concerned, equivalent operation can be obtained; hence, equivalent economies.

The practical operation of Walschaert motion is best shown by the testimony of roads using it in considerable numbers, and at a recent meeting of motive power officers and locomotive builders, held to discuss the results of the use of Walschaert motion engines, the roads represented having about 1,000 such engines, it was the unanimous opinion that Walschaert motion was equally well adapted to fast and slow passenger and freight service; that equivalent economies in fuel and water were obtained; that no reductions of tonnage ratings were necessary; that expense of maintenance and repairs were reduced; that inspection and repairs were facilitated; that construction advantages in the way of frame-cross bracing, etc., were increased; that valve adjustments made are maintained and engines kept square much longer on account of the motion being more direct, rigid and positive for the passage of the valve-driving stresses; and that convenience of the enginemen, inspectors and shop men is promoted by the accessibility of the motion.

The discussion thus far has been with reference to the valve actuating mechanism proper, as ordinarily used on locomotives for operating the usual types of slide or piston valves. There are available for the use of railroads some patented forms of valve motion or systems of steam distribution which are claimed to obtain economies superior to those of the types already mentioned.

The Young valve gear has been applied to engines with Stephenson link and later a Walschaert motion having some detail modifications from the regular design has been proposed. The motion acts upon a wrist plate which has connections to two semi-rotary valves, and the effect of the combination produces valve events remarkable on account of absence of pre-admission, small amount of lead, quick port opening, large exhaust area and fine equalization of the events. It is claimed, due to these features, that fine performance and superior economies are obtained which more than compensate for the cost of maintenance of additional parts required.

For the past six years, the Allfree-Hubbell designs for improving steam distribution have been under test and the designers have made changes from time to time. The first design or "geared system," as the designers called it, has been superseded by what is known as their "compression system," some of which have been in service for several months. This design is supposed to embrace the economic features of the original design with some additions, and, as it now stands, it attempts to produce the following results: late release, late compression, low clearance, balanced compression, reduced cylinder radiation, quick admission and quick release. In the later design an auxiliary valve has been introduced for the control of compression alone, and allows the main valves to be made and set for a desired release with the Stephenson link, Walschaert, or any other motion, all the changes being made in the cylinders and valve alone.

This device has been under test on several roads and from an average of several reports it seems to give about 6 per cent. reduction in fuel consumption and 5 or 6 per cent. increase in train load, and is able to maintain the same or a little more speed than engines of the same size and ordinary design, except the cylinders. There is also a lighter drain on the boiler for steam, but we are unable to express the amount in figures. In making a study of this system for causes of the results claimed, we find a very late compression, which, according to the argument of the designers, means that the negative working pressure is acting at a time when it produces the least effect on crank pin. In other words, when the crank pin is very near the center, from this point alone, an increased load is possible, not so much from an increased working pressure as from a reduced negative work. In view of the above argument any given load could be handled with a less amount of steam, which means a less amount of coal and therefore brings the handling of greater load within the possibilities of the boiler. In addition to this, the reduced clearance is claimed to be responsible for a considerable steam economy.

Locomotive Lubrication.

Committee—D. R. MacBain, R. D. Smith, R. F. Kilpatrick, C. Kyle, W. O. Thompson.

With reference to high steam pressure and superheated steam.

At the 1906 convention, your committee reported that for locomotives with steam pressures as high as 225 pounds, or those using superheated steam, the temperature of which is as high as 600° F., the ordinary valve oil had been found by experience to be quite suitable, and the problem is one of delivering the oil in proper quantities to the places needing it; your committee believes the latter is possible with the modern sight-feed lubricators now in use.

How far may we economize in lubrication, both internal and external?

Internal Lubrication.

Internal lubrication should not be stinted, for it is more important that an engine perform its work properly and without undue wear or heating. Dry valves and dry cylinders mean rapid wear of the surfaces of contact in the steam chest and cylinders, also excessive trouble with the valve motion parts. Too much economy in the use of oil for internal lubrication is apt to result in hot or slipped eccentrics, broken eccentrics, eccentric straps, links, transmission bars, rockers, valve stems, and connection pins, and aside from the increased machine friction, the performance of the engine is affected. Hard-running valves cause a derangement in steam distribution, and worn packing in valve chambers or at rods causes a loss due to leakage.

With the slide-valve locomotive there is not so much danger of these troubles, as the jar of the reverse lever attracts attention to the fact that oil is needed and the engineman will see that the valves are properly lubricated. With piston-valve locomotives the internal lubrication may be much below the required amount without any indication from the reverse lever, and the cause of the trouble may operate a long time before being discovered; in other words, the engineer on a slide-valve engine, even on a small allowance of oil, is more apt to keep the valves supplied with enough oil to prevent hard service to the machine, while with piston-valve engines he does not have this indication that the valves need oil, and no one knows that the parts have been running too dry until trouble comes through heated bearings and worn or broken parts.

Your committee feels that for internal lubrication, 70 miles per pint for large freight locomotives and 80 miles per pint for large passenger locomotives seems to be the amount needed to lubricate properly. The amount for each class depends upon the speed at which the locomotive is running; in bad water districts the oil allowance should be increased about 25 per cent.

External Lubrication.

The use of grease on crank pins and driving axles seems to offer the best solution of how to decrease the cost of external lubrication and at the same time secure the best results. The committee report of last year gave some experiences with 203 locomotives, showing that grease as a lubricant, gave results about as follows:

(a) Reduces engine failures due to heated journals and pins.
(b) Reduces cost of lubrication.
(c) Reduces cost of labor incident to inspection, cleaning and renewal of lubrication packing.
(d) Reduces delays incident to oiling.
(e) Reduces cut journals incident to oil lubrication.
(f) Possibly produces a slight increase in machine friction.

In reference to the cost of external lubrication as compared with that of, say, four years ago, your committee believes that the cost per square inch lubricated, or per pound carried, is less with the use of hard grease than when oil was in general use.

The consideration of sight-feed lubricators versus pumps for internal lubrication.

Your committee is of the opinion that a well-designed sight-feed lubricator, having pipe connections suitably arranged to deliver the oil in the most direct way to the parts needing it, will under present conditions do the work properly. On superheated locomotives it is, we believe, generally conceded that there should be one pipe from the lubricator leading direct to the cylinders and attached to separate plugs near the center, so that the oil fed from the lubricator for the cylinder may be properly distributed. The question of location of plugs in the steam chest is one point on which we find considerable difference of opinion; one member of your committee, who has had considerable experience with superheated steam, favors putting the steam chest plugs at the end of the valve chest in preference to attaching the oil pipe to the center of the chest and letting the oil be carried by the steam to the parts where needed; and your committee as a whole believes that the question of locating steam chest connections is one that can be left open, and, therefore, do not care to make any recommendations.

Subjects.

COMMITTEE REPORTS.

1. Laboratory test of the various valve gears in use—Stephenson, Walschaert, Alfree-Hubbell, and Young—at Purdue or Altoona, to determine their relative efficiency. R. D. Smith (Chairman), F. H. Clark, W. F. M. Goss.

2. Best system of washing out and refilling locomotive boilers, including blow-off lines, flushing tanks, hot wells, and other similar methods and data pertaining to benefits in the way of reducing defects in fire-box sheets, staybolts and tubes. H. T. Bentley (Chairman), L. H. Turner, W. R. McKeen.

3. Organization of large railroad shop forces. H. H. Vaughan (Chairman), James Milliken, W. H. Lewis, T. S. Lloyd, A. E. Manchester.

4. A system of accounting for labor and material for railway repair shops. H. Emerson (Chairman), T. H. Curtis, Le Grand Parish.

5. Handling scrap. H. D. Taylor (Chairman), D. J. Redding, A. Forsyth.

6. The use of castellated nuts for machinery of locomotives with a view of having some standard dimensions established. Committee to be appointed by the executive committee.

INDIVIDUAL PAPERS.

Is it desirable to have uniform specifications and drawings of locomotives covering the most common types and sizes? To be presented by Mr. G. M. Basford.

Standard definition of the term "engine failure," with a list of locomotive characteristics and the numerous varied conditions of operation on which any definition would need to be predicated, in order to enable comparison to be made. To be presented by Mr. M. K. Barnum.

Design and strength of crank axles for balanced compound locomotives. To be presented by Mr. F. J. Cole.

Committee—Henry Bartlett (Chairman); J. A. Carney, R. P. C. Sanderson.

(To be continued.)

MASTER CAR BUILDERS' ASSOCIATION.

FORTY-FIRST ANNUAL CONVENTION.

The convention was called to order on the Steel Pier, Atlantic City, June 17th, by Mr. W. E. Fowler, president. Mr. Fowler's address indicated a very careful and comprehensive study of the work before the Association and was enthusiastically received. He spoke of what had been accomplished in the past, reviewed the reports to be considered at the convention and made a number of valuable suggestions as to the future work of the Association. One of the most important of these may best be presented by quoting from the address as follows:

"Some of the railroads of this continent have, in times past, generously contributed not only the time of officials, but, in many cases, materials and equipment towards the advancement of committee research, and I believe that there will always be a spirit of this kind manifested by progressive railroads. But, the problems confronting the Master Car Builders' Association, which were in the past solved by the exercise of good judgment, by careful observation or by averaging the experience of all interested parties, must in the future, in my opinion, be supplemented by the precise methods of science, and materials which were unknown to our fathers, but which promise valuable assistance, must, in many cases, have their physical properties and chemical composition made known, before they can be used in practical railroading.

"Considerations such as these suggest to me the desirability of the organization by the Master Car Builders' Association, of an expert staff, which would be qualified by education and training to handle problems either mechanical, chemical or physical.

"Such an organization should have its home in a laboratory befitting the dignity of the great interests represented by this Association, such as would be possible at Purdue University, or a similar institution. Not only would the members of such a staff be able to give their undivided attention to the problems of this Association, but the sustained character of their efforts would make their work cumulative.

"Bringing to bear upon the problems with which they were confronted, minds trained for scientific research and habituated to the study of railroad problems, the work of such investigators should be invaluable. Operated under the direction of the executive committee of the Master Car Builders' Association, and sustained by all the railroads of the country, such a laboratory and staff, actually in co-operation with the working committees of this association, would return many times its cost to the railroads of the country.

"I am aware that this organization cannot be arranged for in a day, it must have a small and inconspicuous beginning, but, as that has been the history of this Association, I do not think that should deter us from entering, at an early date, upon a plan which will permit an early organization of a small staff of this kind, upon a permanent basis, and I would recommend that this convention request its executive committee to consider and act upon this idea, if it deems it advisable."

The members of the Association have come to look upon the address of Mr. E. A. Moseley, secretary of the Interstate Commerce Commission, as one of the most important features of the convention and because of the events of the past year it was looked forward to with even more eagerness than usual. He called attention to several developments which have recently taken place, spoke of complaints which had been received concerning the condition of the equipment and plainly stated the position which the Interstate Commerce Commission intended to take in regard to them. Of the various defects constituting the basis of prosecution, inoperative uncoupling mechanism constitutes a large majority, there being 672 cases of this character.

The secretary's report showed a total membership as follows: 336 active members, 249 representative members, 14 associate members, 15 life members; total, 614. The number of cars represented is 2,047,327, an increase of 207,070 over last year.

The treasurer's report showed a balance of $6,640.69.

Mr. John T. Chamberlain was elected an honorary member.

REVISION OF STANDARDS AND RECOMMENDED PRACTICE.—The report of this committee was exceptionally complete and indicated much careful and painstaking investigation and study. In the absence of Mr. T. S. Lloyd, the chairman, the report was presented by Mr. C. A. Seley. A large number of the recommendations were referred to letter ballot, including slight changes in the 5 x 9 and 5½ x 10 journal boxes, the changing of the radius between the wheel seat and rough collar on axles, the specifications for brake beams, the adoption of a standard straight link handbrake chain, certain changes in the standard for the protection of trainmen, etc.

ARBITRATION COMMITTEE.—Part of the report referring to the placing of advertisements on cars was modified and the date for the final equipment of cars with standard air-brake hose was extended to September, 1908. The report including these modifications was accepted and adopted.

TRIPLE VALVE TESTS.—The report was accepted and the committee continued.

BRAKE SHOE TESTS.—The committee presented as an appendix to the report a very carefully prepared study and summary of the work of the brake shoe committee extending over the past 12 years. This was prepared by Mr. F. W. Sargent, of the American Brakeshoe & Foundry Company. Recommendations made by Mr. Sargent as indicated by the following extract from his paper were referred to the executive committee:

"The M. C. B. record of shoe tests, while most important and valuable, will remain incomplete until checked up by service tests. The brake-shoe testing machine records results under ideal conditions—a steady wheel moving true with a constant uniform braking load and perfect contact between shoe and wheel, with clear, dry surfaces in contact under practically uniform climatic conditions.

"In actual service we have the reverse, namely, an unsteady wheel pounding along over uneven track, more or less elasticity in brake beams and brake connections, and fluctuation in braking pressure, coupled with the varying contact between wheel and shoe with extremes of climatic conditions from cold to hot and wet to dry.

"The test wheel is uniform in its bearing against the shoe, and always moving in the same direction, the projections tend to bend away from the shoe and the surface of the wheel to polish up and to smooth over and afford a better contact than in the case of the wheel in service conditions. With the ordinary car wheel the unflanged brake shoe covers that part of the wheel not in contact with the rail, as well as that part of the wheel which is in contact with the rail; so that there are two distinct surfaces under the shoe. The side motion of the brake shoe is continually varying the amount of contact between the shoe and these two surfaces, while the inequalities of track condition and the pounding of the wheel cannot do otherwise than break the grip of the shoe on the wheel, all of which means that the actual coefficient of friction from the service tests is much less than that indicated in the shop test.

"To make the records complete, therefore, some connection should be made between shop and service tests, and to my mind this can be done without very much trouble and expense. The management of some of the electric roads in the West, in the vicinity of Purdue University would, I believe, be much interested in conducting a service test of brake shoes with a heavy electric car in interurban service, using unflanged M. C. B. Christie type of brake shoes on 33-inch wheels, and I believe a series of tests could be arranged using brake shoes previously tested on the M. C. B. machine, and after service stops had been made, returned to the machine for further test. It would not be necessary to test all the various types of brake shoes, but say three different kinds of shoes illustrating those in general use on locomotives, steel-tired coach wheels and chilled wheels."

The committee was also instructed to test the wearing as well as the frictional qualities of the shoes and to determine the relative wear on the wheel.

TESTS OF M. C. B. COUPLERS.—In the absence of the chairman the report of the committee on this subject was read by Mr. Kleine. It was announced that, although the name of Mr. T. H.

Curtis did not appear with the committee on the report, he fully concurred in its recommendations.

Mr. F. W. Brazier said that he believed the maintenance of the draft rigging and couplers was the most important feature in the car department work. The trouble along these lines was on the increase. One of the greatest difficulties he had found was the fact that repair parts were not always duplicates of the original, and hence did not fit properly. He considered that nothing but the best material should be used for knuckles and that great care should be given to seeing that they were exact duplicates in size with the original. It might be necessary to even go to the drop forged knuckle. Expense should not be considered in this connection.

Mr. R. P. C. Sanderson endorsed all that Mr. Brazier had said. He moved that the recommendations be submitted to the committee on standards and called attention to recommendations No. 1 and No. 10, with which he did not fully concur.

Mr. J. J. Hennessey questioned the judgment of having a 2½ in. movement between the horn of the coupler and the face plate. He also believed that the side movement recommended was excessive, and stated that while it would give relief to the end of the car it would throw greater stress on the flange of the wheel, which is the weakest part of the car structure.

Mr. C. A. Schroyer upheld Mr. Hennessey's remarks in connection with the longitudinal movement of the draw bar, especially in connection with broken links and clevises of the uncoupling apparatus. His road had been having a great deal of trouble with these parts being broken.

Mr. McIntosh took issue with Mr. Hennessey in regard to the side clearance, stating that he had been operating cars for two years with a greater clearance than that recommended, with entire satisfaction. He believed that it had had a favorable effect on the flanges of the wheels.

Mr. F. H. Stark disagreed with Mr. Hennessey in regard to the longitudinal movement of the coupler, stating that he believed that it should be even more than at present, because of the impossibility of stopping the momentum of the cars so suddenly, as the draft gear fails to absorb the shock in short movements and transfers it directly to the car frame.

Mr. E. A. Moseley drew attention to the fact that the elimination of broken chains and the attachment for lifting the pin would largely do away with further prosecution of railroads by the Interstate Commerce Commission. He urged the importance of finding some way of remedying this trouble.

Mr. T. H. Russum believed that the flange wear would be considerably helped by more lateral movement of the coupler. He also thought that some uncoupling attachment could be devised which would eliminate the use of the chain.

Mr. C. H. Schroyer moved the appointment of a committee on couplers relative to the use of an unlocking apparatus that will do away with chains, with the understanding that the device recommended should be applicable to every coupler on the market. This motion was carried.

Rules for Loading Long Material.—The report was presented by Mr. A. Kearney and, upon the motion of Mr. Sanderson, was accepted and referred to letter ballot.

Cast-Iron Wheels.—The report was read by Mr. William Garstang, who also presented a letter from Mr. Muhlfeld, a member of the committee, stating that he did not concur with the recommendations in several particulars, which particulars were stated and will be published in the proceedings. A letter from the car wheel manufacturers was also read, drawing attention to the fact that the increase in the thickness of the flange added about 15 lbs. to the weight of the wheels, and hence the weights as specified for 33-in. wheels should be increased by this amount, unless there was a decrease in section at some other point.

Mr. J. J. Tatum took exception to the committee's recommendations for the limit of flange wear, which was specified to be 1⅛ in. for 100,000-lb. capacity cars; 1 1/16 in. for 80,000-lb. cars, and 1 in. for 60,000-lb. cars. He believed that 1 in. should apply for both 60,000 and 80,000-lb. cars, and that 1 1/16 in. should be allowed on the 100,000-lb. cars. He stated that in his experience the greater number of broken flanges were practically full size flanges, indicating that the limit wear is not going to help matters materially as far as broken flanges are concerned, and that the increase of 1/16 of an inch would allow a much increased mileage.

Mr. R. L. Kleine stated that his experience was that from 50 to 60 per cent. of the total number of flange breakages on 100,000-lb. capacity cars were below the 1⅛-in. limit, and that a limit placed at that figure would save that many broken flanges, and hence was of vital importance. He recommended that the gauge shown in the committee's report for flange wear should have the radius at the fillet or throat of the wheel at 3/16 in., the present standard, instead of ⅜ in., as recommended.

Mr. A. W. Gibbs stated that the Pennsylvania Railroad had in the year 1904 voluntarily increased the limit of flange wear to 1⅛ in. with a most decided improvement. This improvement, however, might partially be attributed to the coned tread which was adopted in 1903. He believed that flanges broke not because they were thin, but because there had been so much peening action by the rail, tending to wedge the flange of the wheel. The amount of wear was a direct measure of the amount of this peening.

Mr. F. F. Gaines stated that while probably 90 per cent. of the broken flanges on his road were full flanges, yet he agreed with the committee's report in respect to the stronger standard at that point, as one broken flange which had worn too thin, causing a wreck, would more than pay for the decreased mileage of the rest of the wheels.

The question of the increase of the size of the fillet in the throat above 11/16 in. was taken up and several members stated that they had obtained considerable improvement by an increase in the radius at this point. The subject was finally disposed of by a motion that the committee be instructed to change its recommendations to include a symbol designating the new wheel and that the words "normal diameter" in paragraph 4 be stricken out. The recommendations as thus changed will be submitted to letter ballot.

Arch Bars for 80,000-Lb. Capacity Cars.—The report was read by Mr. C. A. Seley, received and referred to letter ballot.

Air Brake Hose Specifications.—The report of this committee was read by Mr. Parish and the committee was continued.

Chemical Analysis of Air-Brake Hose.—The report was read by the secretary and accepted, and the committee was continued.

High-Speed Brakes.—The report of this committee was read by Mr. F. M. Gilbert, received and referred to letter ballot.

Height of Brake Staff.—The report of the committee was read by the secretary.

Mr. C. A. Seley moved that the report be received with the exception of that portion relating to the distance of the staff from the center of the car, which is already covered in the standards for the protection of the trainmen, and that it be referred to letter ballot. This motion was finally carried.

In the discussion of the motion Mr. C. A. Schroyer called attention to the height of the standard cars recommended by the American Railway Association and urged that the members give particular attention to the recommendations of this committee when voting by letter ballot.

Mr. R. P. C. Sanderson stated that he did not believe the height of the car had anything to do with it, but that the committee's recommendations were such as to allow the cars to pass freely in interchange, and that the governing feature was the clearance on important railways. In this connection Mr. Trimyer stated that the clearance line of the N. Y. N. H. & H. R. R. is 14 ft. 3½ in. from the top of the rail.

Automatic Connectors.—The committee on this subject reported as holding no meeting during the year, hence no report was submitted and no action was taken.

Tank Cars.—The report of this committee was read by Mr. C. M. Bloxham, who called the attention of the members to the reasons for the changes as recommended in the report. He also supplemented the report by a discussion of the advisability of

omitting the stenciling of the tare weight and capacity weight on the car and recommended that Rule 23 be revised by the insertion of the words "except tank cars." The subject of stenciling the cars was thoroughly discussed from both sides, and was finally disposed of by a motion that the recommendations of the committee be accepted and referred to letter ballot, except the part referring to the stenciling, which should be submitted to letter ballot under a separate heading.

STRESSES TO WHICH WHEELS FOR 10,000-LB. CAPACITY CARS ARE SUBJECTED.—The chairman of the committee, Mr. J. F. Walsh, reported that the committee had found the subject so difficult as to be beyond its powers and advised that it be turned over to some specialists who are equipped with apparatus for making tests. He reported that Mr. George L. Fowler was preparing to make some experiments along these lines.

Mr. Fowler gave a brief outline of the nature of the apparatus he had designed and stated that he hoped by next year to have some interesting figures at hand.

It was moved and carried that the committee be discharged, and that Mr. Fowler be requested to present an individual paper on the subject at the next meeting.

CLEARANCE OF ELECTRICAL EQUIPMENT.—A letter from Mr. Deems was read by the secretary, which stated that the matter was now in the hands of a committee of the American Railway Association, which included practically the members of the M. C. B. committee, and that no report would be made by that committee at this time.

SUBJECTS.—The report of the committee was accepted and referred to the executive committee.

ELECTION OF OFFICERS.—The election of officers for the coming year resulted as follows:

President—G. N. Dow, General Mech. Insp., L. S. & M. S. Ry., Cleveland, O.

First Vice-President—R. F. McKenna, M. C. B., D. L. & W. Ry., Scranton, Pa.

Second Vice-President—R. W. Burnett, A. M. C. B., Can. Pac. Ry., Montreal, Can.

Third Vice-President—T. M. Ramsdell, M. C. B., C. & O. Ry., Richmond, Va.

Members of the Executive Committee—D. F. Crawford (P. R. R.), T. H. Curtis (L. & N. Ry.), and F. H. Clark (C. B. & Q. Ry.)

TOPICAL DISCUSSIONS.

LATERAL COUPLER CLEARANCE.—This subject was opened by Mr. Parish, who stated that the large amount of trouble with flange wear and breakage on his road had led them to try experiments with greater side clearance on the couplers. They had tried a clearance of 4 in. in place of the standard 2½ in. for two years with excellent results. The wheel flanges showed but little wear, and the general condition of the cars was good. He advocated the appointment of a committee to thoroughly investigate the subject and report next year.

Mr. Hennessey did not agree with Mr. Parish on this point, believing that greater coupler clearance would throw greater stress on the wheel flanges.

Mr. Gaines suggested that if a committee was appointed it should also investigate the desirability of a centering device in connection with increased clearance.

Mr. J. J. Tatum believed that all strains should be removed from a car as far as possible. If the coupler binds it should be given more clearance.

Mr. DeVoy stated that the experiments he had conducted indicated that an increase of coupler clearance over the present limit would result in increased flange breakage.

Mr. Brazier reported good results with the increased clearance. He hardly considered a centering device necessary, as with the wide yoke strap and a draft gear with initial compression, the coupler centered itself very nicely.

Mr. J. J. Tatum reported some tests he had made on sharp curves which indicated the desirability of more clearance in some cases.

Mr. Seley drew attention to the matter of overhang and wheel base having an effect on the coupler clearance.

Mr. W. F. Kiesel stated that the tests he had made indicated the desirability of more side clearance for couplers.

Mr. Fuller called attention to the difference between steel and wooden cars in the matter of requiring greater clearance. The wooden cars were not giving any trouble, but he had found it necessary to consider the matter very carefully on steel cars.

Other members spoke, usually in favor of greater clearances.

TRUCK SPRINGS ON JOURNAL BOXES RATHER THAN UNDER THE BOLSTER.—This subject was opened by Mr. F. W. Brazier, who stated that in his opinion the best arrangement of the springs in a truck was that which would most effectually cushion all moving parts. Thus by placing the springs on the journal box the non-spring supported parts were reduced to a minimum and the result will be a much longer life to the truck itself and less damage to tracks and bridges. The weight of the non-spring supported part of an arch bar truck having 5½ x 10 in. axles is about 11,000 lbs. This could be reduced to 5,200 lbs. by placing the springs over the boxes. He reported that his company had over 30,000 cars equipped with trucks having springs over the boxes and also over 1,000 tender trucks of the same design, all of which had given excellent service.

He further stated that while he did not wish to be considered as defending the Fox type of truck, he would say that they had less trouble with that truck than any other type, and also that less than 1 per cent. of the derailments were with this type of truck. In reply to a question he stated that he had not noticed any difference in the wear on the journals between the Fox truck and the arch bar truck.

SOLID STEEL WHEELS FOR PASSENGER SERVICE.—The discussion of this subject consisted of a detailed account of a series of tests which had been made and were reported by Mr. George L. Fowler. He had gone into the physical and chemical qualities of the material in the solid steel wheels very carefully and also experimented with the wearing qualities in actual service. The conclusions that he reached from these experiments were that the metal in the solid steel wheel is fully equal to that of the ordinary steel tire and that in other respects the solid steel wheel was equal in every way to the steel tired wheels and that it simply remains a question of price and value of scrap to decide which wheel to use in passenger service.

UP-TO-DATE CLEANING OF PASSENGER EQUIPMENT.—Mr. P. H. Peck opened the discussion by giving a description of the coach cleaning yard, equipment and methods used on the Chicago & Western Indiana Railroad, where from 6,000 to 7,000 cars per month are cleaned. This included the cost of cleaning the different cars which gave an average for nearly 90,000 cars of 77.8 cents.

Mr. McIntosh reported that the vacuum system of car cleaning in use on his road had been so satisfactory that they now considered it almost indispensable.

Mr. Brazier stated that in the new yards which were being installed on his road both the exhaust and straight air systems were being used. He drew attention to the fact that there was a great diversity in the application of the term "car cleaning," which might mean almost anything from a walk through the car to a thorough scrubbing.

Mr. B. Julian stated that he believed that the vacuum system was the best for cleaning cars. He considered it cheaper than straight air when all things are considered.

Other members described various systems in use on other roads and there was a very general desire for information as to the cost of cleaning by the vacuum system as compared with straight air.

PASSENGER CAR VENTILATION.—The discussion of this subject was opened by Mr. McIntosh, who covered the requirements of satisfactory ventilation in a somewhat extended manner and pointed out the limitations of most of the ordinary schemes. The chief of these is the fact that ventilation depending upon the moving train ceases when the car stops. He thought it quite possible that some scheme might yet be evolved which would be operated by a system of independent motors and would furnish constant and controllable ventilation which would be perfectly satisfactory.

Mr. Schroyer described the ventilators in use on the C. & N. W., consisting of a jack located in the roof of the car, being continued inside by a tube which conducts the air over the radiator and discharges it into the body of the car at the floor level. He had examined many ventilating devices, but as yet had found nothing that answered the purpose as well as this device.

Mr. R. L. Kleine discussed the system in use on the Pennsylvania, which was evolved by Dr. Dudley a number of years ago.

Abstracts of Committee Reports.

Brake Shoe Tests.

Committee—W. F. M. Goss, G. W. West, B. D. Lockwood.

The results of tests made on a shoe submitted by the C. C. C. & St. L. R. R. were presented.

In its report to the 1906 convention the committee called attention to the fact that up to that time the activities of the committee on brake shoes had been confined to a study of frictional qualities, and the importance of some work being undertaken which might lead to information concerning wearing qualities was urged. The practicability of such tests was shown, and a design for a proposed addition to the testing machine which would make them possible was presented as an appendix to the committee's report.

From a study of the problem the committee reached the conclusion that tests to determine the durability of the shoe might readily be made in the laboratory, provided some additional mechanism could be attached to the brake-shoe testing machine. The purpose of the proposed addition would be to permit the shoe to be brought in contact with the wheel of the testing machine for a predetermined interval, after which it would be automatically released, remaining in release position for another and a much longer interval, during which time both wheel and shoe would return to their normal temperature. It was believed that by such a cycle any shoe could be given a definite amount of exposure to wear, that a comparatively short interval during the application and a much longer one during the release would avoid all chances of excessive heating, and that by its automatic action the motion of the machine could continue hour after hour, with but little attention from the laboratory attendants. Accessory to the large machine there would of course be required a registering counter to show the number of applications, and a delicate balance for weighing the shoes before and after they are exposed to the action of the machine.

A mechanism which, when applied to the existing testing machine, would give the function above described, had been designed under the direction of a member of your committee, by Mr. Fritz Ernst. Mr. Ernst being no longer available for the work of your committee, the whole problem of design and construction was generously undertaken by Prof. W. P. Turner, of the department of practical mechanics of Purdue University. As a result of his study it seemed best to abandon entirely the lines previously laid down and to employ compressed air for bringing about the required movements, the supply and discharge being governed by a light and comparatively inexpensive valve driven by gear connections with the testing-machine shaft. A detailed description of the added equipment as designed by Professor Turner and constructed under his direction is given in the appendix. It need only be said here that under the control of the apparatus the brake-shoe testing machine may be run steadily at any given speed, the shoe being automatically applied and released. The apparatus was placed in service early in April and has since been employed in tests. Two sets of connecting gears are at present supplied. By the use of one, hereafter referred to as Gear A, the shoe is in contact with the wheel approximately 1-10 of the total time and by use of the other, hereafter referred to as Gear B, ¼ of the total time. The exact action is as follows:

THE CYCLE AS CONTROLLED BY GEAR A.

Revolutions during which shoe is in contact with wheel..... 160
Revolutions during which shoe is out of contact with wheel..1,440

Under the control of this gear 1,600 revolutions, or approximately the equivalent of 2.6 miles running, were required for each complete cycle. After some preliminary running it was decided that progress under this cycle was unnecessarily slow.

THE CYCLE AS CONTROLLED BY GEAR B.

Revolutions during which shoe is in contact with wheel..... 190
Revolutions during which shoe is out of contact with wheel.. 610

Under the control of this gear 800 revolutions, or approximately the equivalent of 1.3 miles running, were required for each complete cycle. It was found that by employing a speed equivalent to twenty miles an hour and a brake-shoe pressure during application of 2,808 pounds, the machine could be kept in continuous motion under the cycle without undue heating either of the wheel or shoe. The severity of test conditions may be judged by the fact that the work done by the brake shoe during each application is approximately the same as that which would be done by each of the eight shoes of a loaded 100,000-pound capacity car in bringing the car to rest on a level track from a speed of forty miles an hour. Shoes giving a high coefficient of friction, however, are under test conditions exposed to action which is somewhat more severe than that which would be required to stop the car. Under these conditions the wheel never became more than sensibly warm to the touch, and the shoe never excessively hot.

Shoes subjected to wearing test.—In selecting shoes for test, it was thought proper to take those for which frictional results were reported last year. Fifteen such shoes were available. All had been submitted for test by railway companies, and had been taken from service after having been about half worn.

The tests to determine resistance to wear.—The cycle employed was that obtained by use of Gear B and the conditions were those mentioned in connection with a description of that cycle. Briefly stated they are as follows:

Diameter of test wheel, inches..... 33
Material of test wheel.....Cast iron
Revolutions per cycle 800
Revolutions during which shoe has contact with wheel..... 190
Revolutions during which shoe is out of contact with wheel.. 610
Brake shoe pressure, pounds.....2,808
Revolutions per minute 204
Equivalent speed in miles per hour..... 20

By the maintenance of these conditions it was found easily possible to secure from eighty to a hundred applications in a single day's run.

In anticipation of a test, the shoe was carefully weighed on an accurate balance. It was then exposed to wear in accord with the program already set forth. A registering counter attached to the machine gave a record of the number of contacts. Weighings of the shoe made at intervals as the work proceeded, clearly showed that the loss of weight was always proportional to the number of stops. While the balance used in weighing the shoes was so delicate as to permit a determination of the loss for a single application, the values reported have in all cases been determined from a considerable number of applications for which the gross loss in weight was so great as to admit of no considerable error in determining its value. The results are given in columns one to eight of Table I.

TABLE I
WEAR OF BRAKE SHOES ON CAST IRON WHEELS

SPEED CONSTANT AT 20 MILES PER HOUR. PRESSURE OF SHOE ON WHEEL 2808 POUNDS REVOLUTIONS OF WHEEL DURING APPLICATION 190. EQUIVALENT DISTANCE RUN DURING APPLICATION 1641.5 FEET.

NUMBER OF SHOE.	RAILWAY CO SUBMITTING SHOE	MARKINGS ON SHOE	COEFFICIENT OF FRICTION	WEIGHT OF SHOE, POUNDS.	NUMBER OF APPLICATIONS	TOTAL LOSS OF WEIGHT POUNDS	LOSS OF WEIGHT PER APPLICATION POUNDS	1,000,000 FOOT-POUNDS OF WORK ABSORBED PER APPLICATION	1,000,000 FOOT-POUNDS OF WORK ABSORBED PER MATERIAL LOST
1	2	3	4	5	6	7	8	9	10
158	HOCKING VALLEY RR	S IF STREETER	22.5	22.046	90	.229	.002544	1.036	407.2
161	"	◇	21.8	21.208	94	.644	.006850	1.004	146.6
163	AT & SF RR	BXU 36 PAT EF 20 1900	21.7	19.964	118	.337	.002856	1.000	350.1
172	AT & SF R.R	G 79-B	22.8	17.180	90	.366	.004066	1.050	258.2
175	W & LE R.R	MBC STD 33	30.3	11.202	40	.690	.017250	1.395	80.8
178	"	33 IN PAT. 1.5.04	20.0	18.662	90	.364	.004044	.921	227.7
179	"	PITTSBURG BR. SHOE CO	36.8	9.238	40	.593	.014825	1.695	114.3
183	O M & N RR		38.7	7.846	60	.615	.010250	1.782	173.8
186	"	C-23	24.1	13.778	90	.615	.006833	1.110	162.5
194	L S M S RR	LAPPIN	26.5	22.730	90	.198	.002200	1.220	554.6
200	"	STREETER	22.7	15.780	90	.243	.002700	1.045	387.0
203	"	STEEL BACK L S & M S CARS	23.5	17.610	90	1.058	.011755	1.082	92.0
209	"	STEEL BACK PULL. CARS	24.7	16.818	90	.593	.006588	1.137	172.0
215	D S S & A RR		20.9	16.354	90	.320	.003555	.963	270.9
220	C & A RR	AM. CAR & FDY CO.	26.5	13.066	91	.220	.002417	1.220	504.7

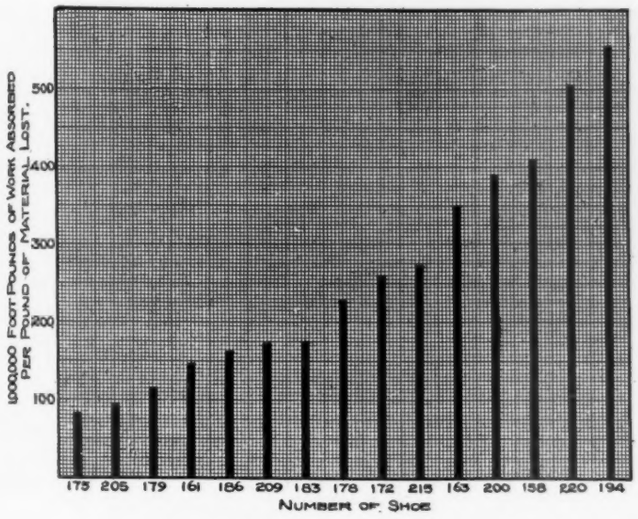
NOTE.

Shoe No. 194 under markings on shoe should read.....C. & N.-W. 8386.
Shoe No. 203 under markings on shoe should read.....P. C. P G 3960 Pat. 4-11-93.
Shoe No. 209 under markings on shoe should read.....M. C. B. triangle enclosing U, U G-36 G.
Shoe No. 215 under markings on shoe should read.....4—83.
Shoe No. 220 under markings on shoe should read.....F 38.

A basis for comparison.—It is apparent that no measurement of wear is complete which does not take into account the frictional qualities of the shoe; that a true measure must include both wearing and frictional qualities and this is best expressed in terms of energy absorbed per unit of weight of material lost. Assuming that the conditions affecting the exposure of the shoe to wear are equally fair to all shoes tested, comparisons upon

this basis should constitute a satisfactory measure by which to determine the relative value of the different shoes as a means of stopping trains. Such a comparison is presented in column 10 of Table I, and is graphically shown by the accompanying diagram. A more detailed explanation of Table I is as follows:

Column 4 gives the coefficient of friction as reported to the convention of 1906. Column 5 is the weight of the shoe at the beginning of the wearing test. Column 6 shows the number of applications made. Column 7 gives the total loss of weight in pounds. Column 8 gives the loss of weight per application. This equals the total loss of weight divided by the number of applications. Column 9 shows the number of million foot-pounds absorbed per application. This is found by multiplying the pressure contact (2,208 pounds) by the coefficient of friction (column 4), by the distance in feet passed over by the surface of the wheel during the application (1,640), and by dividing by one million. Column 10 shows the million foot-pounds of work which can be done by each shoe under conditions of test for each pound of material lost. It is obtained by dividing the values of column 9 by those



of column 8. That the values in column 10 vary between wide limits is best shown by the diagram accompanying.

As to the significance of results.—In carrying out the tests all shoes were subjected to the same exposure to wear. Whether the relative results would be the same had the conditions of test involved lighter pressure or higher speeds than those which were actually employed, is a question which the committee has not yet had time to determine. It is not impossible that a shoe giving a relatively poor performance under the conditions of the test would show relatively better under some other conditions. If, for example, shoes are designed for specified service, it would perhaps be unfair to expect all to show at their best under a single condition of operation. The probability is, however, that a shoe which is good under one condition of running will not be bad under other conditions. But, as has been stated, these are questions which have not been studied, and the results as set forth in the accompanying diagram should be accepted, not as an absolute measure of the relative values of the shoes in question, but rather as an exhibit of facts obtained by a process which is clearly described and the significance of which each member will be able to judge for himself.

A Missing Factor.—It is a matter of regret that no measure has yet been made which will disclose the wear of the wheel under the influence of the shoe. To secure such a measure, it will be necessary to have a balance of sufficient capacity to weigh the wheel and of such delicacy as to indicate differences in weight as small as one five-hundredth part of a pound. No such balance is now available at the laboratory. The possibility that some of those shoes which show high performance in the accompanying diagram may have been protected from wear at the expense of the wheel makes it highly desirable that precise information be had.

Future Plans.—The preceding statements show the possibility of formulating a prescribed laboratory test covering the wearing qualities of shoes. Enough has been accomplished to reveal both the intricacies and the value of a much more elaborate study of the brake-shoe problem. It would seem that the time has come when mechanical tests could very profitably be supplemented by chemical analyses of the shoes tested, to the end that, step by step, the problem may be proven. Thus far the committee has not involved the Association in any considerable expense. It would be well if, in further expression of its interest, the Association could provide a fund sufficiently large to permit the committee to proceed actively for a considerable period along both mechanical and chemical lines.

The committee acknowledges its indebtedness to Mr. L. E. Endsley, instructor in the locomotive laboratory of Purdue University, for assistance rendered in the operation of the brake-shoe testing machine.

Tank Cars.

Committee:—A. W. Gibbs (Chairman), C. M. Bloxham, Robert Gunn.

It has developed that confusion exists at interchange points in regard to the phase of the specifications which covers construction "as strong as"; and it has actually developed that the same car might be accepted by inspectors on one part of a system and held up by inspectors on the same system at another point. This has entailed much vexatious delay and a very considerable amount of correspondence. In consequence, a meeting was held of representatives of a number of railroads handling a large number of tank cars, and the points causing confusion were discussed and amendments suggested in the wording of the requirements.

It is but fair to the committee to state that when the necessity for some regulation in regard to tank cars first arose, the construction of this class of equipment was, in general, stereotyped and bad, although there were certain ownerships whose cars were a notable exception. The committee recommended a standard which should be considered as a minimum requirement, but which has evidently been understood by many owners to be an expression by the committee of what is good enough. In the meantime, the severity of the service to which all classes of equipment are subjected has undoubtedly changed for the worse, and while the committee is not yet prepared to withdraw the earlier drawings covering minimum requirements for tank-car construction, it feels very strongly that it is to the interest, not only of the transportation companies, but, also, of the car owners as well, to very materially exceed the requirements for strength.

The committee suggested a number of changes in the specifications to make them clearer and more effective.

Air Brake Hose Specifications.

Committee—Le Grand Parish (Chairman), Jas. Milliken, F. A. Torrey.

The committee on air brake hose specifications wishes to call the attention of the association to an error in the specifications for air brake hose, as submitted to the association last year, and recommends that the following correction be made:

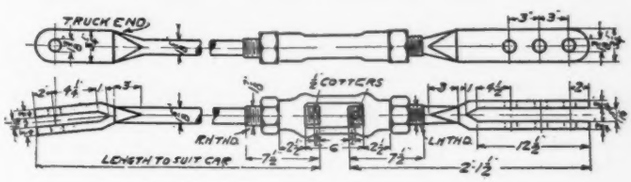
It will be seen that the label on the hose and M. C. B. Sheet No. 9 give the diameter of the hose as 1¼ inches, while in the detail of the specification the minimum diameter of the hose is shown to be 1⅜ inches; therefore, the label and the cut on M. C. B. Sheet No. 9 should be changed to 1⅜ inches.

The committee does not feel that any change should be made in the present specifications for the reason that last year it recommended that a chemical test be added to the specifications, and as a special committee is at work on this, we feel that no change should be made until this committee shall have completed its investigations and its report has been accepted.

High Speed Brakes.

Committee—F. M. Gilbert, chairman; S. G. Thomson, C. B. Young.

Provide for taking up the slack on six-wheel trucks, which accumulates from brake shoe wear, by substituting adjustable connection shown by attached sketch; substituting this connection for the one described on M. C. B. Sheet J as B-C7-A. The pro-

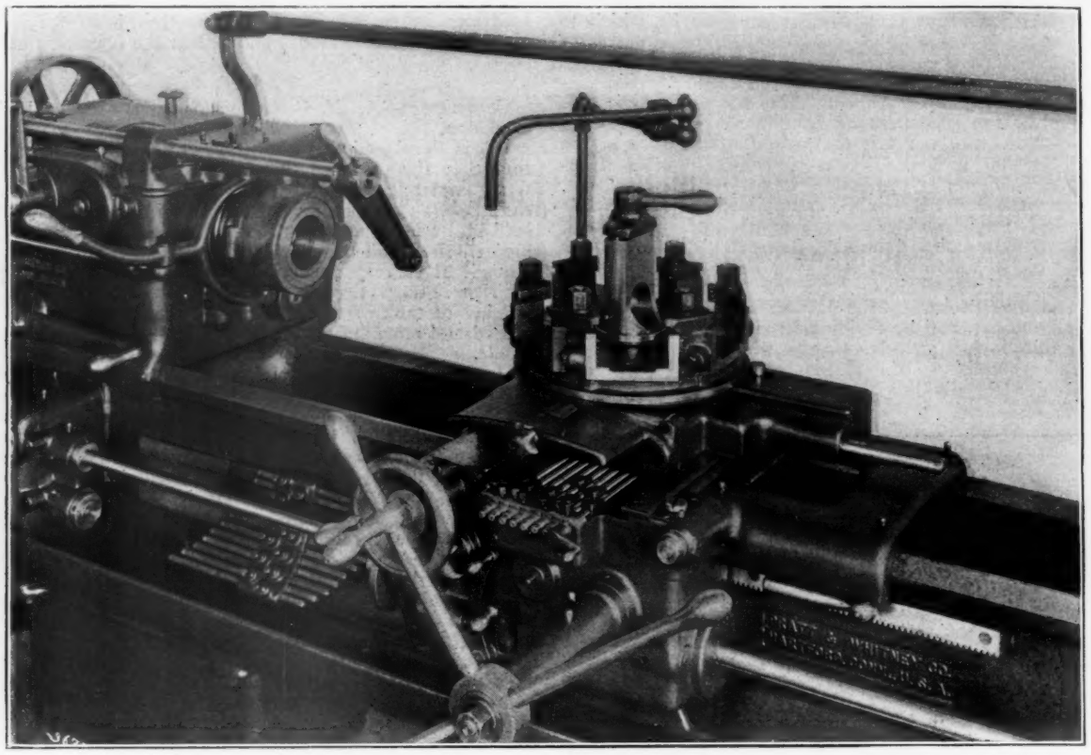


posed connection has been tried out in service and found satisfactory.

The committee also suggests the addition to the different schedules of notes giving more prominence to the maximum theoretical load which may come on beams.

(To be continued.)

EXTRA WORK DEPARTMENT OF THE BALDWIN LOCOMOTIVE WORKS.—The annual amount of duplicate parts supplied in recent years is the equivalent of about 100 new locomotives. In 1906, 368 pairs of cylinders were ordered and 80 boilers. In 1905, 196 locomotives were overhauled and put in first-class working condition.—*Arthur L. Church in "Record of Recent Construction," No. 60.*



OPEN TURRET LATHE—PRATT & WHITNEY.

2½ X 26 INCH OPEN TURRET LATHE.

The new Pratt & Whitney 2½ x 26-inch open turret lathe shown in the illustration is a universal machine suitable for doing a large variety of work from the bar and on forgings and castings, without continually requiring special appliances and expensive cutting tools. To accomplish this purpose, many new features, including a cross sliding turret, have been introduced. The machine possesses practically all the flexibility and adaptability of the engine lathe. The extreme rigidity, powerful spindle drive, quick changes of speeds and feeds, heavy cross feeding turret and numerous adjustable stops, admit of narrower limits of error, as well as a marked reduction in the cost, over work produced on the ordinary turret or engine lathe.

It has a stiff head, and may be driven either by a direct-connected motor or a countershaft drive by means of a single pulley. The turret is mounted on a slide, having both positive power and hand-longitudinal and traverse directions. The machine is recommended for bar work up to 2½ in. diameter x 26 in. long, for castings up to 14 in. diameter, and for cylindrical operations on work within these limits.

An unusually heavy spindle of special steel, with cylindrical bearings, runs in bronze split sleeves. The thrust of the spindle is against an independent upright, cast solid with the head, and insures against any springing tendency under heavy end cutting strains. Provision is made for taking up wear of the spindle and end thrust. The direction and speed of the spindle are controlled by levers operating friction clutches. It is impossible to connect more than one set of gears with the spindle and the main driving shaft at the same time. The gears are of extra heavy pitch and of ample width to withstand safely the hardest usage. The head, which is stationary, is of box construction, the gears running continually in oil. Eight variations of speed are provided, and by using a two-speed countershaft this may be doubled. All of the controlling levers and connections are within easy reach of the operator. The spindle can be instantly stopped by the movement of any lever on the head stock.

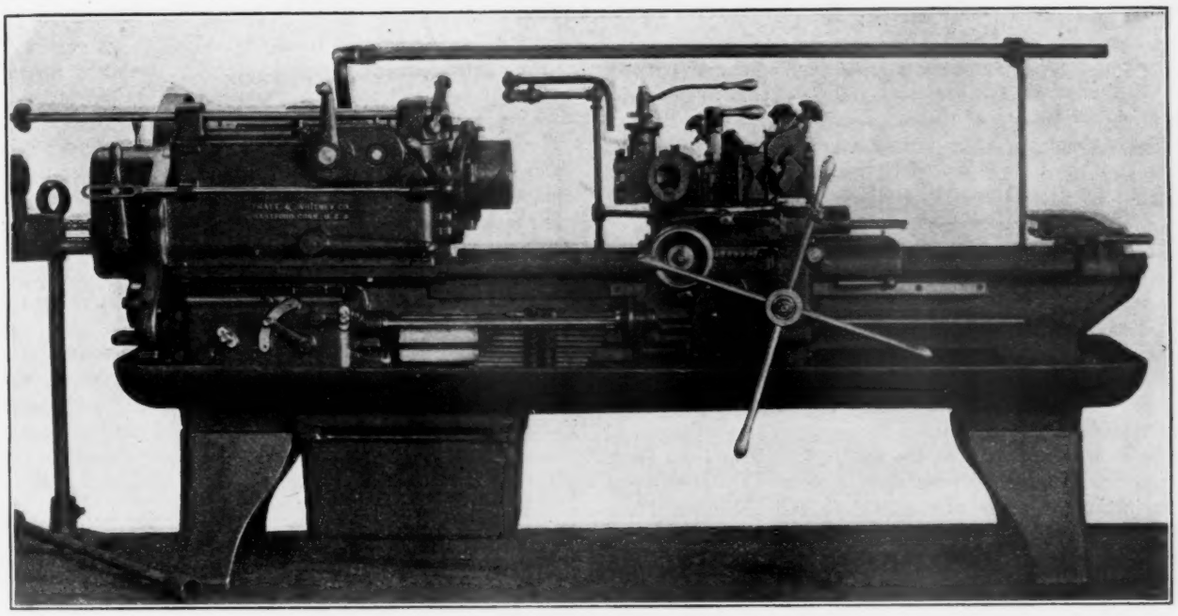
The rod chuck may be operated while the machine is running, and has extraordinary gripping power. The collet jaws are supported up to their outer end, which is especially desirable in forming work from the cross slide. The complete chuck can be removed readily from the spindle when combination lathe chucks or special face plates for castings are to be substituted. A positive screw feeding device automatically feeds the rod forward to its stop.

The bar may be round, square, hexagon, or of any irregular cross section, and need not necessarily be free from scale, as there are no delicate parts or complicated gearing to become clogged. A follower bar is furnished which enables short pieces of stock to be as conveniently handled as long bars, and at the same time serves to keep such pieces concentric with the spindle. An efficient stock stop for gauging the length of stock is provided, which, when not in use, is moved forward and swung upward, so as not to interfere with the turret tools.

The turret revolves about a large conical stud held firmly in the cross slide. The various tools may be accurately located and with rigid backing, so that the heaviest cuts may be taken without the slightest spring or backward movement. The tools are held in place by straps and are backed up by uprights cast solid with the turret. Severe tests have proven this to be a superior method of unyieldingly holding the tools against all torsional and backward strains. The locking-bolt is directly under the cutting tool and is horizontal, thereby overcoming the tendency of a vertical bolt to lift the turret from its seat.

Indexing can be accomplished at all positions of the cross-slide, and is automatic, although the turret may be rotated to any position by hand. One of the most important features in this lathe is the compound turret with power and hand feeds and adjustable stops which are conveniently located. The longitudinal turret slide travels on large raised "V's," is provided with gibs its full length, and a binder which permits the slide to be firmly clamped to the bed at any point within its travel. The power longitudinal feed is positive in both directions, and has six changes, any one of which can be set instantly.

There are six automatic longitudinal stops and six supplementary stops, which give two positions to each turret tool. If necessary, all twelve stops may be used for one or all tools in the turret, making it possible to effectively cover all requirements. The stops are held in a heavy steel bracket, which may be moved along the front of the bed and clamped where desired. In case it is desired to run through a few special pieces of work, the automatic stops may be dispensed with and the supplementary stops used in their place without the necessity of disturbing adjustments.



PRATT & WHITNEY 2½ x 26 INCH OPEN TURRET LATHE.

The distance from the axis of the spindle to the turret tool is altered by traversing the turret slide. This arrangement permits ample support for long bars, and if the machine is belt driven, gives an unvarying belt tension. A motor can be mounted on the head without difficulty. The cross slide has both hand and power feed. There are six variations of the power feed in either direction. Eight distinct adjustable cross stops are provided, which may be used in any combination desired.

The bed and pan are made in one single casting and have "U"-shaped cross webbing insuring rigidity. Generous provision for oil and chips is provided. A variety of turret tools adapted to meet practically all the various requirements are furnished to order.

AN IMPROVED TOOL POST FOR SLOTTERS.

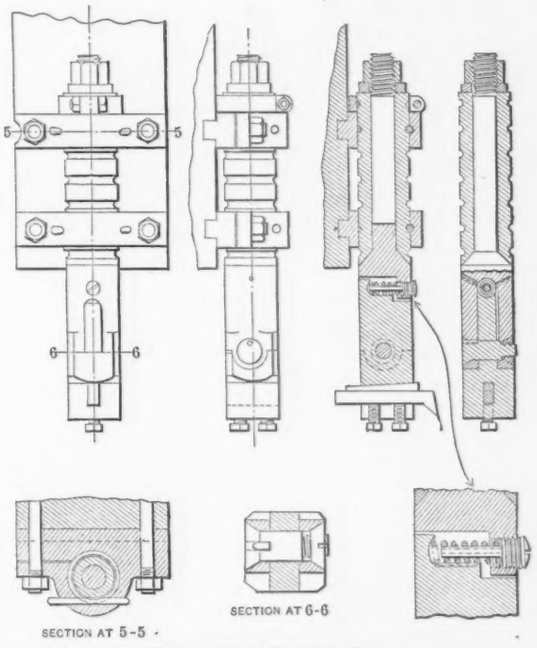
The tool post, shown in the illustration, is adapted for use on such machine tools as slotters, planers and shapers. It has a self-contained relief mechanism, so designed that high-speed tool steels may be operated to the limit of their cutting capacity. The illustrations show the tool post applied to a slotter. It is of simple and substantial construction; easy of adjustment; works equally well on long or short strokes, in corners, keyways, deep recesses, on plane surfaces and circles, and with the tool extended in any direction from o to 360 degrees about the vertical axis in a horizontal plane or with the feed coming in at any time or place.

It is so graduated that the work may be adjusted from it without having to move the carriage, thus saving considerable time and labor, especially on large parts such as locomotive frames. When large or irregular pieces are placed on the machine the post is simply slipped up out of the way and can easily be dropped back when the work is in place.

The construction is clearly shown on the drawings. The upper part or sleeve is clamped to the ram of the machine. Annular grooves are cut on this sleeve at intervals and by means of pins which pass through the clamping brackets the sleeve can be locked in place, insuring it against the possibility of being forced upward under heavy duty. The several annular grooves on the sleeve permit it to be closely adjusted to suit the work. By loosening the clamping bolts the sleeve can be adjusted about its own axis. The clamping collar at the top prevents the tool from dropping in case the clamps are loosened and the pins removed at the same time.

The upper part of the post has a forked lower end and a stem which passes through the sleeve and is held in place by the nut and washer at the upper end. The joint between this piece and the sleeve at the lower end is such that when the nut at the top is tightly drawn up any tendency toward lateral movement due to a loose fit between the sleeve and the stem is prevented. When the nut is loose the post may be swiveled to any position. These two parts have gauge marks upon them so that they may be brought to any predetermined position. One of the marks on the sleeve extends up to the clamping bracket upon which there is a corresponding mark and when these register the work on the table can be squared up and put in proper position by it, as a portion of the post at its lower end is squared for this purpoce. Pieces can thus be adjusted with less work than if adjusted from the table.

The lower part of the post is pivoted to the forked end of the upper part, as shown. The lower part can swing backward slightly on the return stroke, the spring forcing it into place as soon as the tool escapes from the work. The tension of the spring may be adjusted to suit conditions by means of the screw and, if desired, the post may be made rigid by screwing it tightly against the shoulder of the lower member. The pivot upon which the lower part swings is placed to one side of the center



TOOL POST FOR SLOTTERS.

so that the faces of the two parts which come in contact when the tool in cutting will be of ample area.

The cutting tool is held in place by the tapered key and also, if desired, by the two set screws. This tool post has been in service at the Brightwood shops of the Big Four Railroad at Indianapolis, Ind., for about a year with very successful results and was designed and has been patented by Mr. William T. Slider, of Indianapolis.

4-CYLINDER DEGLEHN COMPOUND 10-WHEEL LOCOMOTIVE.

PARIS-ORLEANS RAILWAY.

The Baldwin Locomotive Works has recently built twenty 10-wheel locomotives for the Paris-Orleans Railway of France from drawings furnished by the railway company. The drawings had all of the dimensions given in the metric system and the work was performed in the shop from those dimensions, necessitating the introduction of many new standards and gauges and the training of the workmen in handling the new system.

These locomotives, as far as the cylinders, valve motion and the general features of construction are concerned, are practically identical with the DeGlehn compound purchased by the Pennsylvania Railroad in 1904, which was very completely illustrated and described in this journal June, 1904, page 203, and reference should be made to that description and accompanying complete drawings for the arrangement of this type of locomotive.

In brief, these locomotives are of the 4-cylinder balanced compound type, with the outside high pressure cylinders connecting to the second set of drivers and the inside low pressure cylinders connecting to the cranked axle of the forward drivers. The cylinders have independent valve gears, both of the Walschaert type, the outer one being driven by the return crank and the inner one from eccentrics. The low pressure cylinders are set directly below the saddle, which forms part of the same casting, while the high pressure cylinders are set some distance back of this. The high pressure valves are of the balanced slide type, being constructed of bronze, while the valves of the low pressure cylinders are non-balanced, also of bronze. They have inclined seats and their steam chests are formed within the cylinder casting. The cylinders are set on an inclination of 3½ per cent. Steam is conveyed to the high pressure cylinders through outside steampipes, and a special valve is arranged between the high and low pressure cylinders permitting the engine to be worked simple or compound as desired. The exhaust is carried through a high exhaust pipe with a variable exhaust nozzle.

The boiler is of the Belpaire type, built of steel plates, with the exception of the inside fire-box, which is of copper. The fire-box is between the frames and the grate is inclined toward the front at a very sharp angle. The staybolts in the water legs are of manganese bronze. The tubes are of the Serve pattern. The throttle valve is of the sliding type and is fitted with the pilot valve, which opens first. The pressure on the main valve is thus equalized and it may be readily moved upon its seat.

The frames are of the plate type and wrought iron driving boxes are used. The weight is transferred to the frames through underhung springs and forged steel equalizing beams.

The engine truck side frames are of a slab form placed inside the wheels. The weight is transferred to the truck through two hemispherical bearings, whose centers are 35½ in., being measured transversely. These bearings are seated in suitable castings which can slide on a heavy cast steel cross tie. Lateral motion of the truck wheels is also provided and is controlled by means of coiled springs. The center pivot supports no weight and is used simply for pushing the truck.

The tender is carried on six wheels, the two rear pairs of which are equalized. The frames are of the plate form placed outside of the wheels. The general dimensions of these locomotives are as follows:

GENERAL DATA.

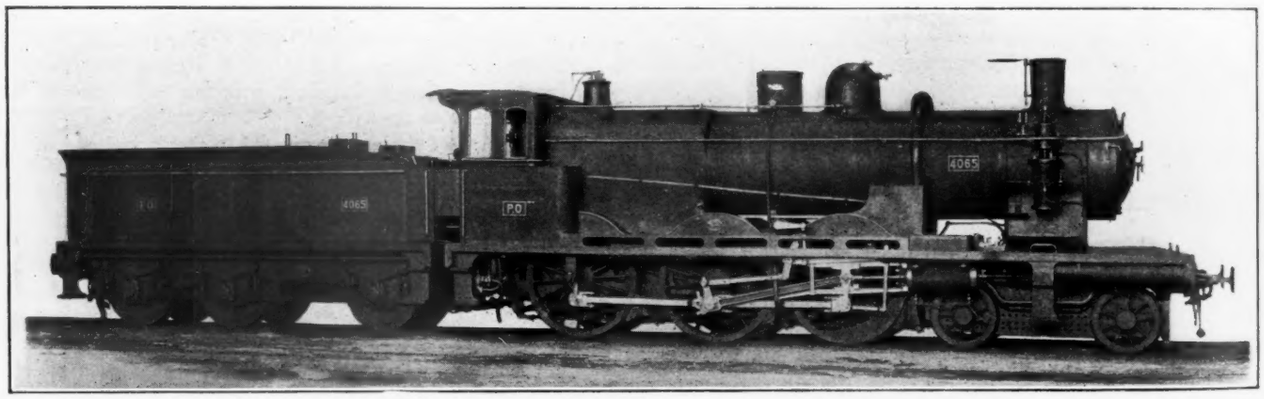
Gauge	4 ft. 9 ins.
Service	Passenger
Fuel	Coal
Tractive power	21,466 lbs.
Weight in working order	152,900 lbs.
Weight on drivers	110,000 lbs.
Weight on leading truck	42,900 lbs.
Weight of engine and tender in working order	195,000 lbs.
Wheel base, driving	13 ft. 9.36 in.
Wheel base, total	27 ft. .08 in.
Wheel base, engine and tender	48 ft. 8.04 in.

CYLINDERS.

Kind	DeGlehn Comp.
Diameter	14.17 and 23.62 in.
Stroke	25.20 in.
Kind of valves	Slide

WHEELS.

Driving, diameter over tires	72.84 in.
Driving journals, diameter and length	8.55 x 9.1 in.
Engine truck wheels, diameter	37.8 in.
Engine truck journals	5.9 x 9.85 in.



DEGLEHN COMPOUND TEN-WHEEL LOCOMOTIVE—PARIS-ORLEANS RAILWAY.

BOILER.

Style	Belpaire
Working pressure	227 lbs.
Outside diameter of first ring	59.57 in.
Firebox, length and width	119.8 x 39.37 in.
Firebox plates, thickness	1.18 & .63 in.
Firebox, water space	S — 2.91 — F & B 3.74 in.
Tubes, number and outside diameter	139 — 2.76 in.
Tubes, length	14 ft. 7.39 in.
Heating surface, tubes	2402 sq. ft.
Heating surface, firebox	174 sq. ft.
Heating surface, total	2576 sq. ft.
Grate area	35.36 sq. ft.

AN APPRECIATION.

The following item, which is taken from the *Daily Railway Age,* has met with such hearty approval and so clearly expresses our own sentiments that we take this opportunity of giving it a wider circulation:

"Probably few of the members of the Master Mechanics' Association or others who have charge of the design and operation of railway repair shops appreciate fully their indebtedness to one who is rarely missing from any meeting of this association or

others having somewhat similar reasons for existence. Indefatigable in research, with unfailing memory for the slightest detail which may have a bearing upon the general principle involved, his chief work is of the kind that is largely done in seclusion or as an incident to more apparent but much less important work, and often appears to public gaze only under the guise of a plan, for which, frequently, if not always, the major credit goes elsewhere. Employed by one of the large corporations, that corporation itself has little knowledge of the work upon which he may have been engaged, when apparently not engaged at all, only as some improvement in design or method makes itself at last apparent as a valuable economic expedient.

"At the same time, in the true spirit of all scientific investigation the results of all his studies are ever at the service of those engaged in similar pursuits and it is this perhaps more than anything else, except his pleasing personality, which has given him his present place in the hearts of all railway mechanical men. The reference is obviously to Lewis R. Pomeroy, electrical expert on shops for the General Electric Company."

WHAT'S THE USE?

TO THE EDITOR:

Referring to the last two lines of the efficiency record of H. J. Doe, No. 44, on page 223 of your June issue:

Month	Total Time		Per Cent		Amount		Total Earnings
	Std.	Act.	Eff.	Bonus	Wages	Bonus	
March, 1907.....	322.8	250	129.	49.	85.00	41.65	126.65
April, 1907.....	322.6	233	138.5	58.5	79.22	46.34	125.56
	.2	17					1.09

With a difference of only .2 of an hour in the standard time, the man reduced the actual time 17 hrs., and received $1.09 less for it. Don't you think that John Doe will be inclined to say "what's the use?" MARVIN ELLIS.

YOUNGSTOWN, OHIO.

TO THE EDITOR:

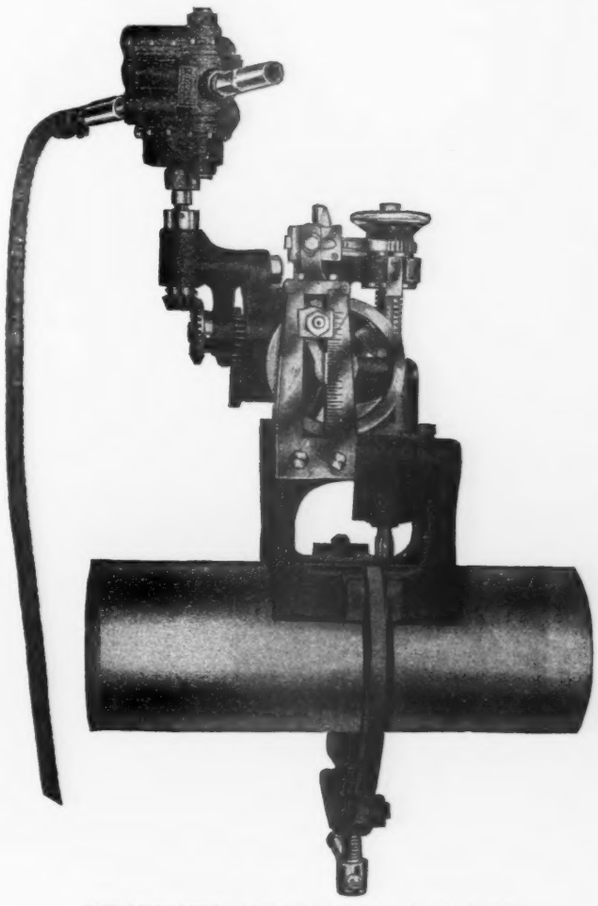
Under the day rate plan in operation at the Topeka Shops before individual effort was introduced, H. J. Doe, No. 44, received wages at the rate of $0.34 per hour. In the month of March, 1907, his wages were at the rate of $0.5066 per hour; in April, 1907, at the rate of $0.5388, an increase in one month of over 6.5 per cent. in hourly rate. Had Doe hired out for April at the hourly rate he was paid in March he would have received $7.52 less than was actually paid him in April.

Marvin Ellis cannot see the bonus payment above standard wages of $46.34, but somehow tries to make out that Doe was swindled out of $1.09. It does not occur to him that Doe's improvement was in part due, possibly largely due, to extra efforts on the part of the foreman, also bonused by the company; to extra expense incurred to furnish Doe promptly with suitable work; to extra expense incurred to see that he received good tools, and that his machine was in good condition. Whereas a piece work rate might have been $0.246 last year it was in March $0.3923 and in April $0.3892, an increase in the first case of $0.146 or 59 per cent., a decrease in the second case of $0.0031, or less than eight-tenths of one per cent. The grasping employer would in fact be shameless enough to go further. If next month Doe delivers 500 standard hours in 250 actual hours, thus showing an efficiency of 200 per cent., his wages will only be increased 120 per cent., his bonus will be only $104, his total pay only $189 and his piece work rate will drop to $0.378. That is the plan under which the unfortunate H. J. Doe works and if he does not like it he can drop back to an efficiency of 90 per cent., earn $8.50 bonus instead of $46.34, but have the supreme satisfaction of working on a piece rate of $0.446.

INDIVIDUAL EFFORT.

PORTABLE AUTOMATIC KEY SEATING MACHINE.

A machine, the usefulness of which can thoroughly be appreciated by all locomotive men by an inspection of the accompanying engraving, has recently been designed and is now being sold by Joseph T. Ryerson & Son, Chicago. The machine is designed for automatically cutting key-ways in locomotive axles, either before or after the engine is assembled. Its operation is entirely automatic when once the machine is in place and set for the proper length key-way. It takes up a space of but 8½ in. on the axle. It weighs but 100 lbs. and is driven by either an air or electric motor, which should operate between 300 and 450 r. p. m. It is designed so that it will cut as close as 1 in. to a driving box or eccentric and the adjustment is such that any



RYERSON AUTOMATIC KEY SEATING MACHINE.

standard size key-way can be cut. It is arranged for use with either new axles or for re-cutting the key-way in an old axle to correspond with the change in the location of the eccentric, thus obviating the necessity of using an off-set key. The machine can be operated in any position on the axle. The time required for cutting a 1 x ½ x 6 in. key-way cannot exceed 35 minutes. The cutters are furnished with the machine and are of special design and made from the best quality of high speed tool steel.

One of these machines was shown in operation at the exhibition at Atlantic City during the mechanical conventions and attracted a large amount of interested attention, which was universally followed by favorable comment.

REFINEMENTS IN DESIGN AND CONSTRUCTION.—There is no doubt that the further development of the steam locomotive will be accompanied by the more extensive introduction of refinements in design and construction, tending to improve the efficiency of the machine. This will necessitate better shop and round house equipment, in order that the motive power may be properly maintained, and worked to best possible advantage.—*Paul T. Warner before the Franklin Institute.*

RADIAL COUPLER AND IMPROVED COUPLER YOKE CONNECTION.

An improved method of connecting the drawbar to the yoke has recently been patented by Mr. J. J. Tatum, general foreman of the car department at the Baltimore Terminals of the Baltimore & Ohio Railroad and by Mr. Alois P. Prendergast, a master mechanic of the same company.

The principal advantages of the device are the dispensing with rivets, its radial feature and the resulting increase in train tonnage with the same locomotive tractive force on divisions where curves are numerous, the great increase in strength as compared to the ordinary type of coupler yoke fastening and the ease with

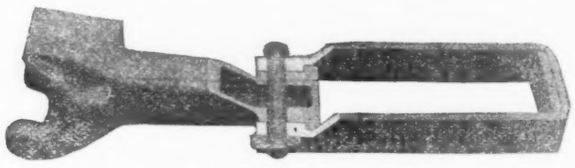
FAILURES OF ORDINARY TYPE OF COUPLER YOKE, AND PIN.

which the yoke may be removed or applied to a drawbar without special facilities and by trainmen or others not skilled in this work. Those who are acquainted with the weaknesses developed by the present type of fastening and the need for a radial coupler can readily understand the marked advantages of this new device from the following description and the drawings.

The bosses on the arms of the yoke are either welded on or the end may be upset and forged to the shape shown in the illustration. These bosses engage with the shoulders on the end of the drawbar. The yokes are now being made on an Acme 3½-in. bolt machine and are fitted to the coupler without any machining. The bosses and shoulders are slightly undercut, so that the tendency under tension is to draw the arms of the yoke together. The pin which ties the two parts together does not take any of the load, and is simply used to prevent the yoke from slipping laterally. The advantages of the radial feature are well understood. The flexible coupler yoke connection eliminates the damaging side shearing effect that is met with in the riveted rigid method of fastening the coupler yoke to the drawbar, now in general use. It reduces the wear of the wheel flanges and rail and greatly reduces the number of accidents due to the breakage of the wheel flanges. It also reduces the side stresses on the car framing and the wear of the coupler and breakage of coupler shanks. Loss of time and the expense of getting cars over sharp curves are eliminated.

The method of making the connection is very simple and inexpensive as compared to the time and cost of applying the ordiordinary type of yoke. The coupler or coupler yoke may be removed and replaced on the line by trainmen or section hands without sending the car to the repair tracks, thus effecting a considerable time-saving as well as reducing the expense.

The strength of the connection is so much greater than that of the present standard that tearing apart will be practically eliminated by its use. The pulling apart of the drawbar and yoke is due to the pulling stresses or shocks, and to gain some idea of



TATUM-PRENDERGAST YOKE.

the relative strength of this form of connection as compared to the ordinary type under such conditions, tests were made under the M. C. B. drop testing machine at Mount Clare.

The two yokes were 1¼ ins. thick and the one for the radial connection was 4½ in. wide or ½ in. wider than the standard yoke because of the 2¼-in. hole, for the pin, in the bosses. The lips on the standard yoke were carefully fitted over the tail of the coupler.

The results of these tests were as follows:

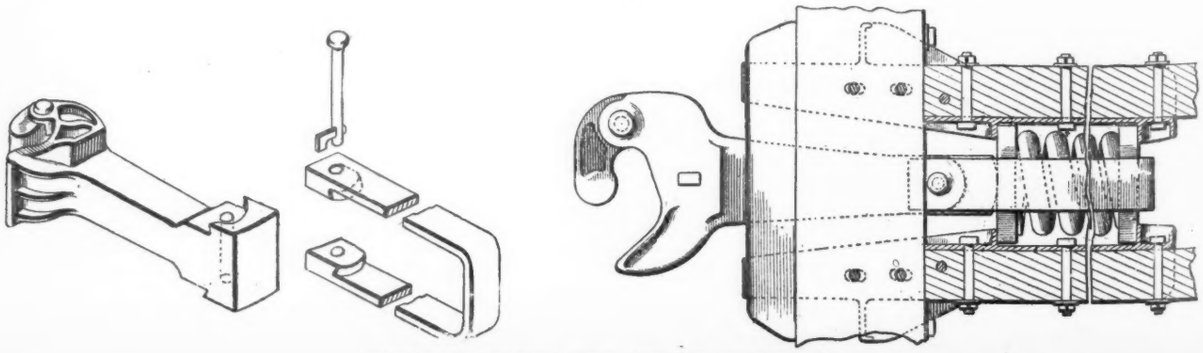
TATUM-PRENDERGAST YOKE.

No. of Blows.	Height.	Rebound.	Remarks.
1	1 ft.	½ in.	
2	2 "	1 "	
3	3 "	1 "	
4	4 "	1 "	
5	5 "	3 "	Cracked at back fillet.
6	6 "	3 "	
7	7 "		Fracture at both back fillets.

This yoke was destroyed without affecting connections at the drawbar.

M. C. B. YOKE.

No. of Blows.	Height.	Rebound.	Remarks.
1	1 ft.	½ in.	
2	2 "	1 "	
3	3 "	1 "	One of the lips cracked.
4	4 "	1 "	
5	5 "		The other lip broken off and both 1¼-in. rivets sheared.



TATUM-PRENDERGAST YOKE AND ITS APPLICATION.

Some of these couplers have been in service for about a year with very satisfactory results. It is possible to arrange the rear end of the drawbar so that it will take either this or the standard yoke.

ARMBRUST BRAKE SHOE.

The brake shoe illustrated herewith is adapted for locomotives, tenders, and passenger and freight cars. It differs from other types of brake shoes in several important features, among which are the following: The shoes are scored across the middle so that any accidental breakage will occur at that point; spacing lugs are cast on the back of the shoe to space the shoe body away from the brake head, thus enabling it to wear entirely out

ARMBRUST CAR SHOE.

without danger of wearing the head, even if it should wear unevenly; a steel connector is cast in the spacing lugs, which construction does not weaken the shoe body.

The scoring of the shoe at the center causes any breakage to occur at that point and permits the shoe to adjust itself to the tread of the wheel, thereby giving better service and adding to the life of the shoe. It also enables the shoe to fit the brake-head at four points of contact, taking the strain off the shoe and throwing it on to the brake-head, where it properly belongs. The steel connector which is cast in the spacing lugs holds the broken parts together in case of breakage which might occur at other points than at the center, thus obviating all danger of

ARMBRUST DRIVER SHOE.

wrecks due to a broken shoe falling to the track. This feature is especially attractive for elevated roads, as there is no danger of broken parts falling to the street.

The body of this shoe, which is known as the Armbrust shoe, can be worn entirely out and is said to be as safe for the last one-quarter inch of wear as at the first. The scrap remaining in a car shoe amounts to about 3 lbs. and in a driver shoe to about 10 lbs.

The driver brake shoe may be pinned to the brake-head the same as the car shoe, or it may be constructed to hook and bolt on the brake-head. With the former construction it is not necessary to have rights and lefts, and therefore the amount of stock which it is necessary to carry can be reduced. This feature permits the shoes to be turned when they are worn more on one end than on another. These brake shoes are manufactured by the Love Brake Shoe Company, whose offices are in the Fisher Building, Chicago, and who at present have foundries at Aurora, Ill.; Augusta, Ga., and Davenport, Ia.

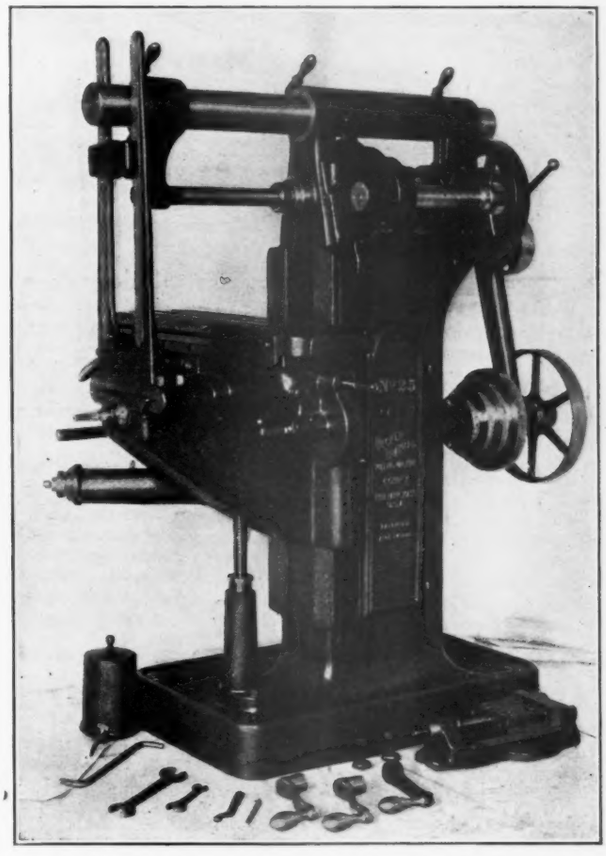
THE RAILROADS.—A commonwealth is dependent upon transportation facilities for its development, and railroads that make large expenditures to render good service at a reasonable cost for the welfare and prosperity of the people who occupy the lands adjoining their tracks, are entitled to reciprocal consideration and an opportunity to expand.—*Mr. J. E. Muhlfeld, before the Railway Club of Pittsburgh.*

PLAIN HORIZONTAL MILLING MACHINE.

The plain horizontal milling machine, shown in the illustration, may be furnished either with or without back gears. Special attention has been given to designing the feed works to withstand the full power of the driving belt and to give good service under rough usage. The feed mechanism is driven by a belt connected to an auxiliary spindle, which receives its motion from the main spindle through a train of gears, so arranged that the belt velocity is sufficient to drive all the feeds that the main belt will stand. The changes of feed are furnished by the four step cones and by interchanging the feed driving pulleys at the rear of the machine, thus giving a total of eight changes from .007 to .100 in.

The table is operated by a worm and a hobbed rack, the worm being of coarse pitch and driven by a large size gear. The feed may be disengaged by means of a novel drop worm mechanism, which overcomes the objection to the old style gravity drop worm of clinging to the gear by friction alone; it also equalizes the wear on the worm gear teeth. The worm is engaged and disengaged by the same lever. The table has a hand quick return of 4 to 1 ratio.

The knee of the machine has been lengthened so that a harness brace may be used for the arbor and still leave a cross range for the table equal to that of the old style machines. This harness consists of a brace which is gibbed to the knee slide and a clamp that is fastened to the arbor support yoke in such a way as to allow it to be swiveled around its centers, allowing the brace to be taken off without removing any bolts. This makes a very stiff brace and the device as a whole adds greatly to the convenience of the machine, as well as increasing the rate at which the work may be handled. The arm is a solid steel bar, which is adjustable lengthwise. The machine has a rigid box knee with a telescopic elevating screw, thus allowing it to be set in any position without regard to the beams or floor construction, as the screw does not project below the floor line. The base is quite similar to other Becker-Brainard machines in that it is extra heavy and capable of absorbing all vibrations. The spindle, cone and back gears are of the standard Becker-



BECKER-BRAINARD PLAIN HORIZONTAL MILLING MACHINE.

Brainard design. The wear of the spindle bearings is taken up by concentric compensating bronze boxes. These machines are made by the Becker-Brainard Milling Machine Company, Hyde Park, Mass. They have a longitudinal feed of 34 in., a cross feed of 8 in., a vertical adjustment of 18 in. and weigh about 1,650 lbs.

IMPROVED PIPE THREADING AND CUTTING OFF MACHINE.

The accompanying illustrations show the largest and next to the smallest of five sizes of improved pipe threading and cutting off machines, which are made by the Armstrong Manufacturing Company of Bridgeport, Conn. These machines are simple, compact and strong in proportion to their weight. The two smaller sizes may be operated either by hand or power, the

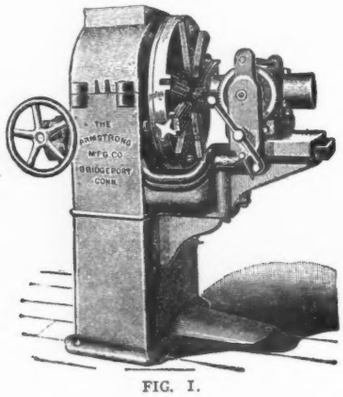


FIG. 1.

smaller one taking from ¼ to 2 in. pipe and weighing, with the dies, about 135 lbs. The largest size cuts and threads pipe from 1 to 6 in. in diameter, and weighs about 1,250 lbs. These machines may also be used for threading bolts, the one shown in Fig. 2 taking bolts from ½ to 1½ in. in diameter.

The pipe is gripped in a powerful self-centering vise which for the two smallest sizes may be screwed to a post, bench, or any temporary support, and with the larger sizes is permanently

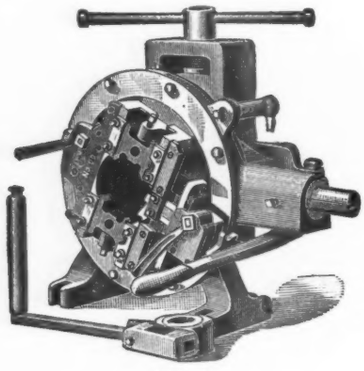


FIG. 2.

built in the stand of the machine. The vise handle is arranged to be out of the way of the operator when threading or cutting, and yet be convenient when it is needed. In front of the vise is the die head carrying a machine counterpart of the Armstrong adjustable stock for hand threading, the die being divided into from two to eight sections, depending upon the size of the pipe. In the two-part dies adjustment is made by individual end screws but in the larger sizes the die sections are moved simultaneously, like the jaws of a lathe chuck, by turning a single screw. The dies used are of the Armstrong make, with their characteristic adjustable features and double taper. They are furnished right or left handed, for pipe or bolts, as may be desired.

The die head has no gear teeth on the part coming in contact with the shell, while a generous bearing insures firmness and little wear. The driving spindle is carried through the side and its end is squared in the smallest size and provided with a key in the larger sizes, so that a hand crank or power pulley can be slipped on or off at a moment's notice. In the smallest size machine there is a geared spindle in addition to the main driving spindle, so that two speeds are provided, enabling small pipe to be threaded very quickly and giving less speed and more power for pipe from 1¼ to 2 in. This feature is said to be unique in this class of tools; its advantages are manifest.

After the pipe has been threaded a simple motion of the hand wheel or lever causes the die to open. The pipe may then be pushed through and cut off to the proper length. All parts are numbered and are fitted to be interchangeable with others of the same number, so that these machines need not be sent to the factory for repairs. These machines will thread and cut off a quarter inch pipe in two and one-half and a six inch pipe in four minutes, with proportionate time for intermediate sizes. All the gears and bearings are enclosed in a dust-proof oil-chamber and good lubrication is thus insured, as well as protection from dust, dirt and metal chips.

The two smaller sizes, the larger of which is shown in Fig. 2, and which will cut 4 in. pipe, can readily be moved to outside work.

NEW TYPE OF MONKEY WRENCH.

One of the smaller exhibits at the Atlantic City exhibition last month, which attracted a large amount of attention, was that of the Bald Manufacturing Company, 603 Farmers' Bank Building, Pittsburg, which exhibited a single monkey wrench of new design, known as the "Miller" wrench. It differs from other wrenches in that the lower jaw is quickly adjusted to a nut by means of a thumb lever, which releases a cam and allows a spring to force the jaw to its adjustment. Upon the release of the thumb lever an eccentric worm is thrown into action which positvely locks the jaw in place and allows the wrench to be used on that size nut as often as desired without further adjustment.

Furthermore, the construction of the wrench is such that the strain is practically all on the jaws. Since the operation is all performed by one hand and the adjustment is immediate and accurate the wrench has a big claim as a time saver. This is one of the many new things shown at the exhibition which have great future possibilities.

PERSONALS.

Mr. D. C. Ross has been appointed master car builder of the Michigan Central R. R., with office at West Detroit, Mich.

Mr. B. S. Hinckley has been appointed engineer of tests of the N. Y., N. H. & H. R. R., with headquarters at New Haven, Conn.

Mr. C. M. Harris has been appointed master mechanic of the Washington Terminal Company, with headquarters at Washington, D. C.

Mr. David Holtz, master of machinery of the Western Maryland R. R., with office at Union Bridge, Md., has resigned and the office has been abolished.

Mr. A. E. Mitchell has been appointed manager of purchases and supplies of the New York, New Haven and Hartford Railroad, with headquarters at New Haven, Conn.

Mr. John Nicholson has been appointed superintendent of motive power of the St. Louis, Brownville & Mexico Ry. at Kingsville, Tex., succeeding Mr. H. H. Kendall.

Mr. M. N. Forney, author of "The Locomotive Catechism," at one time part owner and editor of the *Railroad Gazette* and for many years editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL, was married on June 25 to Mrs. Annie Virginia Spear of Baltimore.

Mr. H. J. Tierney has been appointed mechanical engineer of the Missouri, Kansas & Texas Ry., with office at Parsons, Kan.

Mr. J. B. McIntosh has been appointed superintendent of heat, light and power of the Washington Terminal Company, with headquarters at Washington, D. C.

Mr. A. W. Wheatley, assistant superintendent of motive power and machinery of the Union Pacific, has resigned to become general inspector of the American Locomotive Co. at Schenectady, N. Y.

BOOKS

Tests of Metals, 1906. A report of the tests made on the U. S. testing machine at the Watertown Arsenal, Mass., during the year ending June 30, 1906. Published by the Government Printing Office, Washington, D. C. Address Chief of Ordnance, War Department, Washington, D. C. 645 pages. Cloth, 6 x 9.

This book contains a complete account of the results of the tests made by the government during the past year on various metals and other materials for industrial purposes, which include steel castings and forgings, cast iron, bronze, copper, steel wire, hardened steel balls, steel ingots, rotating shafts, railroad material, concrete, reinforced concrete, brick, sand and paper. It is profusely illustrated with excellent photographs and includes a vast amount of very valuable material.

CATALOGS.

In writing for these catalogs please mention this journal.

SMITH NUT LOCK.—A small folder describing the new nut lock which is manufactured by the Keystone Nut Lock Mfg Company, Commonwealth Building, Pittsburgh, Pa.

STROUSE LOCOMOTIVE STOKER.—The Locomotive Stoker Co., Chicago, is issuing a leaflet describing and illustrating its latest design of stoker which has been in successful service on one of the western roads for a number of months.

"MORE HOLES FOR LESS MONEY."—A small but interesting pamphlet from The Knecht Brothers Company, Cincinnati, Ohio, telling of the advantages of the Knecht friction sensitive drill which may be furnished for either a belt or motor drive.

BOILER SHOP MACHINE TOOLS.—The Queen City Punch & Shear Company, Cincinnati, Ohio, has prepared a number of loose leaves describing their punching and shearing machinery and straightening and bending rolls. They are sending these out in neat and simple binders.

BULLETIN ON ELECTRIC GENERATORS AND MOTORS PRINTED IN SPANISH.—The Triumph Electric Company, Cincinnati, Ohio, is issuing bulletin No. 311, which illustrates and describes its line of steel frame generators and motors, printed in Spanish.

VERTICAL TURRET LATHE.—A small, handsomely illustrated pamphlet describing the vertical turret lathe manufactured by The Bullard Machine Tool Company, Bridgeport, Conn. The inside cover page bears this inscription: "A multi-purpose tool for increasing output and decreasing cost of all face plate work within its range."

THE COUR-CASTLE CORRUGATED LOCOMOTIVE FIREBOXES.—A. M. Castle & Co., 55 N. Jefferson Street, Chicago, is issuing a small catalog descriptive of their depressed, corrugated side sheets. This type of side sheet was illustrated and described in the June issue of this journal, page 247. The catalog also contains a number of complimentary letters from prominent railway officials.

COLUMBIA UNIVERSITY: SUMMER SCHOOL.—The announcement of the courses in engineering, which will be conducted in the summer sessions of Columbia University, beginning July 9th and ending August 17th, is given in a small leaflet now being distributed. This announces two courses in civil engineering and three in mechanical, each of which are given by men prominent in their respective fields and are intended principally for instructors in engineering schools and for technical graduates who desire to keep up to date in their special lines. No examination is required for admission to this school.

THE MODERN CAR FOR PASSENGER TRANSPORTATION.—A booklet of 52 pages, handsomely illustrated, giving a short résumé of the evolution of the steel passenger car as constructed by the Pressed Steel Car Company together with brief descriptions of several types of such cars recently built. One prominent mechanical railway engineer, after glancing over a copy of it at the Atlantic City convention remarked as he put it in his side pocket: "This is worth while taking back home to put in my technical library."

IMPROVEMENT IN LOCOMOTIVE BOILERS.—Mr. William H. Wood, Engineer, Media, Pa., is issuing a small pamphlet descriptive of a number of proposed improvements in locomotive boilers which suggest changes in construction so as to prevent concentration of the stresses, caused by the expansion of the different parts, at the sharp flanges. These suggestions are interesting and worthy of study.

SMALL TOOLS, STANDARDS AND GAUGES.—The Pratt & Whitney Company, Hartford, Conn., is issuing catalog No. 4, which comprises 215 pages, thoroughly illustrating and describing the large and complete line of small tools, standards and gauges for which this company is famed. The book contains complete data, with prices, of the different tools, and also includes some valuable information in the shape of tables of dimensions of standard screw threads, taps, metric standards, weights, etc.

THE STEAM LOCOMOTIVE OF THE FUTURE.—The Baldwin Locomotive Works is issuing Record No. 61, containing an article by Mr. Lawford H. Fry on the above subject. This article appeared in *Cassier's Magazine* in January, 1907, and is one of the best discussions of what the ultimate result of the present tendency in locomotive practice will be, that has appeared in recent years. Mr. Fry includes foreign as well as American locomotives in his discussion, and draws some very rational and interesting conclusions from the study.

EIGHT-WHEEL TYPE PASSENGER LOCOMOTIVES.—A pamphlet recently issued by the American Locomotive Company illustrates and describes different designs of 8-wheel or American type passenger locomotives. This is the eighth of the series of pamphlets which is being issued by this company to cover the various standard types of locomotives. It contains illustrations of 25 different designs of 8-wheel type engines, the principal dimensions of each design being given on the page opposite the illustration. The pamphlet constitutes a very complete record of the production of the company in this type of engine, and the arrangement is very convenient for the selection of a design best suited to meet any particular requirement.

TRACK SUPPLIES AND RAILWAY MATERIAL.—The Buda Foundry & Manufacturing Company, Chicago, Ill., is issuing a cloth bound catalog containing 329 pages, which very thoroughly illustrates and describes the large and varied line of track supplies and material manufactured by this company. This includes track scales, hand push cars, velocipedes, switch stands, ball bearing jacks, and in fact all tools and devices required by the maintenance of way department of a railroad. Among the features in this catalog which are of special interest to the motive power department, are the ball bearing hydraulic, locomotive and car jacks, as well as geared ratchet jacks and hydraulic journal box jacks. These are shown in many sizes and capacities and include several special designs for particular classes of work. The section on car and engine replacers will also be found interesting by motive power men. This part of the catalog contains a number of illustrations showing the Buda replacers in actual service under different conditions.

GRINDING MACHINES.—The Norton Grinding Company is issuing Catalog N-7, entitled, "Norton Plain Machines for Cylindrical Grinding." This is in pamphlet shape, of a size corresponding to the publications issued by the locomotive companies, and contains 63 very interesting pages of information and illustrations on the subject of grinding machines. The machines illustrated, each one of which is shown and described separately, include twelve of the over-head drive type in sizes varying from 6 x 32 in. to 18 x 168 in. Seven machines of the electric drive type are shown in sizes from 10 x 50 to 14 x 72 in., including a car wheel grinder. Six machines of the self-contained electric drive type are shown in sizes varying from 18 x 96 to 18 x 168 in., also including a car wheel grinder. The first and last of these types includes a gap machine, in which piston rods can be ground without removing the piston head. Several illustrations of the work performed on these machines is included, as well as views of the Norton factory at Worcester, Mass. The typographical work of this catalog is excellent, the illustrations being particularly clear and distinct.

SCHOOL OF RAILWAY ENGINEERING.—The University of Illinois is issuing bulletin No. 8 of Vol. 4, descriptive of the new school of Railway Engineering and Administration recently organized. It is stated that the function of this school is to coördinate the various facilities of this university so as to provide specialized training for all branches of railway service and to otherwise further this work. It is the purpose of this school to provide courses of training which shall prepare men to become efficient workers in the financial, traffic and operating, as well as in the engineering departments of both steam and electric railways. At present there are offered the following four courses: railway civil engineering; railway electrical engineering; railway mechanical engineering and railway administration. Each of these occupies four years and the work in each course has been carefully selected to meet modern conditions. The bulletin gives the courses in detail and contains complete information on the material equipment of the university used in this school. The men chosen as instructors have been carefully selected for their fitness and experience, in fact so much care is being given to this point that the position of Professor of Railway Engineering has not yet been filled. This position will require a man of exceptional ability and one who has had experience in the maintenance of way department of railways, as he will be expected to give instruction in the civil engineering courses. The proper man no doubt will be found before the opening of the school next fall. Copies of this bulletin can be obtained by any one interested by addressing the University of Illinois, Urbana, Ill.

PRESSURE GAUGES, INDICATORS, ETC.—The Ashcroft Manufacturing Company, 85 Liberty St., New York, is issuing a 135-page cloth bound catalog which contains brief but complete descriptions of the various specialties, instruments and tools manufactured by this company. These include pressure gauges of all kinds and capacities, automatic recording gauges, revolution counters, gauge boards and panels, gauge testing machines, low water alarms, Tabor steam and gas engine indicators, planimeters, pipe stocks and dies, ratchets, sockets, etc. The typographical work in the book is excellent, the illustrations being printed on heavy coated paper, making them unusually distinct and valuable.

ELECTRICAL APPARATUS.—The General Electric Company is issuing a number of new bulletins. These include No. 4505, which illustrates and describes the new design of commutator pole railway motors, which are at present furnished in sizes varying from 50 to 200 h.p. Bulletin No. 4503 illustrates and describes in detail the CQ generators and balancing sets, which are furnished in capacities ranging from 1½ k.w. to 17 k.w., intended for slow or moderate speeds. No. 4502 is on the subject of knife-blade lever switches, and shows many types and sizes. No. 4493 is a 76-page bulletin giving the parts of R controllers. This is very complete and gives the number, name and price of each separate part of the many different designs of these controllers. The same company is also issuing a pamphlet descriptive of the electrification of the West Jersey & Sea Shore Railroad. This gives complete illustrations of the apparatus and equipment and a brief description of the interesting features.

NOTES

AMERICAN MALLEABLES COMPANY.—Mr. D. J. Carson, who has been in charge of the New York office of the American Brake Shoe & Foundry Company for the past two years, has been appointed manager of the above company.

THE ARNOLD COMPANY.—This company announces that Mr. Alfred R. Kipp, who is a specialist in railway shop work, has recently joined its engineering staff. Mr. Kipp has been in active railroad service since his graduation from Purdue in 1896.

JOSEPH DIXON CRUCIBLE COMPANY.—At a special meeting of the directors of the above company, held May 31, to take action on the recent death of vice-president and treasurer, Mr. John Walker; Mr. George T. Smith was elected vice-president, Mr. George Long, treasurer, and Mr. Harry Daily, director and secretary.

CUTLER-HAMMER MANUFACTURING COMPANY.—This company which has recently purchased the Wirt Electric Co., of Philadelphia, announces that the manufacture of Wirt apparatus, certain types of which, particularly battery charging rheostats and field rheostats, enjoy an enviable reputation, will be continued by it. The current Wirt catalog should be used for the present. The address of Cutler-Hammer Mfg. Co. is Milwaukee, Wis.

CHICAGO PNEUMATIC TOOL COMPANY.—The following cablegram was recently received by the company from its London office. "Boyer Hammer patent sustained by highest English court. Certificate of validity furnished. Competitors taxed with costs and damages—all hammers made declared infringement—decision very important as British patent corresponds to our American patent and covers all practical hammers. Hardest fought and most expensive ligation ever conducted involving a pneumatic tool."

KEITH AND PROCTOR'S JERSEY CITY THEATRE.—This theatre, which is the latest addition to Jersey City playhouses and is as complete in its luxurious appointments as most of the Manhattan theatres, is acquiring a wide reputation for its excellent attractions, its low prices and its comfort, particularly for women and children. Each matinee ticket at 10 or 20 cents entitles its holder to a number in a prize drawing contest, the prizes being cut glass or jewelry. The building is artificially cooled, and is thoroughly comfortable even on the warmest days.

UNFAIR METHODS IN COMPETITION.—S. F. Bowser & Co., Fort Wayne, Ind., has filed a suit in the U. S. District Court at Cincinnati against the National Oil Pump and Tank Company, of Dayton, which charges most unfair methods in competition. This action is supplementary to suit for infringement of patents, which was filed against the same company some months ago and is now pending. It is charged in the later suit that the National Company has closely copied the Bowser cuts and advertising matter, and that it has constructed its goods to closely resemble the Bowser products, thus misleading the customers and taking an unfair advantage of the reputation of the Bowser tanks and pumps.

CONVENTION EXHIBITS.

There were 257 exhibitors at the M. M. and M. C. B. conventions, or 13 more than last year. The uniform arrangement of the booths greatly improved the appearance and the exhibits themselves were more complete than usual. Among the exhibitors were the following:

American Balance Valve Co., Jersey Shore, Pa.
American Blower Co., Detroit, Mich.
American Brake Shoe & Foundry Co., Mahwah, N. J.
AMERICAN ENGINEER AND RAILROAD JOURNAL, New York.
American-Henderson Roller Bearing Co., Chicago, Ill.
American Nut and Bolt Fastener Co., Pittsburg, Pa.
American Locomotive Co., New York.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American Steel Foundries, Chicago.
Armstrong Bros. Tool Co., Chicago.
Atha Steel Casting Co., Newark, N. J.
Baeder, Adamson & Co., Philadelphia.
Besly, Chas. H. & Co., Chicago.
Bethlehem Steel Co., South Bethlehem, Pa.
Bettendorf Axle Co., Davenport, Iowa.
Bickford Drill & Tool Co., Cincinnati, O.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Bliss Electric Car Lighting Co., Chicago.
Bordo L. J. Co., Philadelphia, Pa.
Bowser & Co., S. F., Fort Wayne, Ind.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Buckeye Steel Castings Co., Columbus, O.
Buda Foundry & Mfg. Co., Chicago.
Buffalo Brake Beam Co., New York.
Bullard Machine Tool Co., The, Bridgeport, Conn.
Burnham, Williams & Co., Philadelphia.
Butler Drawbar Attachment Co., The, Cleveland, O.
Cardwell Mfg. Co., Chicago.
Carey Mfg. Co., The Philip, Lockland, Cincinnati, O.
Chicago Car Heating Co., Chicago.
Chicago Pneumatic Tool Co., Chicago.
Cleveland Car Specialty Co., Cleveland, O.
Cleveland Pneumatic Tool Co., Cleveland, O.
Commercial Acetylene Co., New York.
Commonwealth Steel Co., St. Louis, Mo.
Consolidated Railway Electric Lighting & Equipment Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Davis Pressed Steel Co., Wilmington, Del.
Dearborn Drug & Chemical Co., Chicago.
Detroit Lubricator Co., Detroit, Mich.
Dickinson, Paul, Inc., Chicago.
Dill, T. C., Machine Co., Philadelphia, Pa.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Dressel Railway Lamp Works, The, New York.
Drouve Co., The, Bridgeport, Conn.
Dudgeon, Richard, New York.
Duner Co., Chicago.
Falls Hollow Staybolt Co., Cuyahoga Falls, O.
Farlow Draft Gear Co., Baltimore, Md.
Firefight Paint Co., Pittsburgh, Pa.
Flannery Bolt Co., Pittsburgh, Pa.
Flexible Compound Co., The, Philadelphia.
Forsyth Bros. Co., Chicago.
Fox Machine Co., Grand Rapids, Mich.
Franklin Mfg. Co., Franklin, Pa.
Franklin Railway Supply Co., Franklin, Pa.
Frost Railway Supply Co., The, Detroit, Mich.
Galena-Signal Oil Co., Franklin, Pa.
General Electric Co., Schenectady, N. Y.
Gold Car Heating Co., New York.
Goodwin Car Co., New York.
Gould Coupler Co., New York.
Greene, Tweed & Co., New York.
Grip Nut Co., Chicago-New York.
Hale & Kilburn Mfg. Co., Philadelphia.
Hammett, H. G., Troy, N. Y.
Helwig Mfg. Co., St. Paul, Minn.
Hess-Bright Mfg. Co., Philadelphia.
Home Rubber Co., Trenton, N. J.
Homestead Valve Mfg. Co., Pittsburgh, Pa.
Houghton & Co., E. F., Philadelphia, Pa.
Hunt-Spiller Mfg. Corporation, Boston, Mass.
Independent Pneumatic Tool Co., Chicago, Ill.
Jenkins Bros., New York.
Kennicott Water Softener Co., Chicago, Ill.
Kent & Co., Edwin R., Chicago.
Keystone Nut Lock Mfg. Co., Pittsburgh, Pa.
Kinnear Mfg. Co., The, Columbus, O.
Koppel Co., Arthur, Pittsburgh, Pa.
Lawrence Mfg. Co., Philadelphia, Pa.
Livezey, John R., Philadelphia.
Locomotive Stoker Co., The, Chicago.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Lord Co., Geo. W., Philadelphia.
Love Brake Shoe Co., Chicago.
Lucas & Co., John, Philadelphia, Pa.
McConway & Torley Co., The, Pittsburgh, Pa.
McCord & Co., Chicago.
Michigan Lubricator Co., Detroit, Mich.
Nathan Mfg. Co., New York.
National Malleable Casting Co., The, Cleveland, O.
National Railway Publication Co., New York.
Norton, A. O., Boston, Mass.
Norton Co., Worcester, Mass.
Parker Anti-Freezing & Hot Water System, London, Ont.
Perry Side Bearing Co., Chicago.
Pittsburgh Equipment Co., Pittsburgh, Pa.
Pocket List of Railroad Officials, New York.
Railway Age, The, Chicago.
Railway & Engineering Review, Chicago.
Railroad Gazette, New York.
Railway List Co., The, Chicago.
Railway Master Mechanic, Chicago.
Railway World, The, Philadelphia.
Ralston Steel Car Co., Columbus, O.
Refined Iron & Steel Co., Pittsburgh, Pa.
Republic Railway Appliance Co., St. Louis, Mo.
Resteine Co., Clement, Philadelphia.
Ryerson & Son, Joseph T., Chicago.
Safety Car Heating & Lighting Co., New York.
Sellers, Wm. & Co., Inc., Philadelphia.
Shelby Steel Tube Co., Pittsburgh, Pa.
Societe Generale des Freins Lipkowski, Paris, France.
Standard Coupler Co., New York.
Stoever Foundry & Mfg. Co., Myerstown, Pa.
Symington, The T. H., Co., Baltimore Md.
Underwood & Co., H. B., Philadelphia, Pa.
Walworth Mfg. Co., Boston, Mass.
Watson-Stillman Co., New York.
Waugh Draft Gear Co., Chicago.
Western Railway Equipment Co., St. Louis, Mo.
Western Tool & Mfg. Co., Springfield, O.
Western Tube Co., Kewanee, Ill.
Westinghouse Air Brake Co., Pittsburgh, Pa.
Wheel Truing Brake Shoe Co., The, Detroit, Mich.
Wilmarth & Morman Co., Grand Rapids, Mich.